11-21-00 A

EL596839659US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Steinberg, et al.
Title: **INTELLIGENT CAMERA FLASH SYSTEM**
Serial No.: Continuation of 08/624,972
Our File: 29033-0269592

TRANSMITTAL FOR NEW PATENT APPLICATION

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

Re: Continuation Application

Sir:

Enclosed is a new patent application, including:

1. New Application Transmittal (16 pages);
2. Patent application, including 23-page specification, 11 pages of claims, 1-page abstract and 9 sheets of formal drawing;
3. Preliminary Amendment;
4. Declaration and Power of Attorney (copy from parent case);
5. Assignment (copy of recorded assignment from parent case);
6. Small Entity Statement (copy from parent case);
7. Check No. 91474 in the amount of $458.00 for the filing fee;
8. Copy of Notification of Continuation Application filed in the parent case; and

Postcard for date-stamped confirmation of Patent Office's receipt of these materials.

Respectfully submitted,

David H. Jaffer
Reg. No. 32,243

Dated: November 20, 2000

PILLSBURY MADISON & SUTRO LLP
2550 Hanover Street
Palo Alto, CA 94304-1115
Telephone: (650) 233-4510
Facsimile: (650) 233-4545

CERTIFICATION UNDER 37 C.F.R. 1.10

I hereby certify that this correspondence and the documents referred to as attached hereto are being deposited with the United States Postal Service on this date November 20, 2000, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL596839659US, addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

Diana Dearing

Practitioner's Docket No. 29033-0269592 ***PATENT***

Preliminary Classification:

Proposed Class:

Subclass:

NOTE: "All applicants are requested to include a preliminary classification on newly filed patent applications. The preliminary classification, preferably class and subclass designations, should be identified in the upper right-hand corner of the letter of transmittal accompanying the application papers, for example 'Proposed Class 2, subclass 129.'" M.P.E.P. § 601, 7th ed.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventor(s): Eran Steinberg, Hari Vasudev, Sumat Mahra

WARNING: *37 C.F.R. § 1.41(a)(1) points out:*

"(a) A patent is applied for in the name or names of the actual inventor or inventors.

"(1) The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by § 1.63, except as provided for in § 1.53(d)(4) and § 1.63(d). If an oath or declaration as prescribed by § 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to § 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in § 1.17(i) is filed supplying or changing the name or names of the inventor or inventors."

For (title): INTELLIGENT CAMERA FLASH SYSTEM

CERTIFICATION UNDER 37 C.F.R. § 1.10*
(Express Mail label number is mandatory.)
(Express Mail certification is optional.)

I hereby certify that this New Application Transmittal and the documents referred to as attached therein are being deposited with the United States Postal Service on this date November 20, 2000, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL596839659US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Diana Dearing
(type or print name of person mailing paper)

Diana Dearing
Signature of person mailing paper

WARNING: *Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. § 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.*

****WARNING:*** *Each paper or fee filed by "Express Mail" **must** have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. § 1.10(b).*
*"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.*

1. Type of Application

This new application is for a(n)

(check one applicable item below)

☐ Original (nonprovisional)

☐ Design

☐ Plant

WARNING: ***Do not*** *use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. § 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.*

WARNING: ***Do not*** *use this transmittal for the filing of a provisional application.*

NOTE: If one of the following 3 items apply, then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED and a NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION.

☐ Divisional.

☒ Continuation.

☐ Continuation-in-part (C-I-P).

2. Benefit of Prior U.S. Application(s) (35 U.S.C. §§ 119(e), 120, or 121)

NOTE: A nonprovisional application may claim an invention disclosed in one or more prior filed copending nonprovisional applications or copending international applications designating the United States of America. In order for a nonprovisional application to claim the benefit of a prior filed copending nonprovisional application or copending international application designating the United States of America, each prior application must name as an inventor at least one inventor named in the later filed nonprovisional application and disclose the named inventor's invention claimed in at least one claim of the later filed nonprovisional application in the manner provided by the first paragraph of 35 U.S.C. § 112. Each prior application must also be:

(i) An international application entitled to a filing date in accordance with PCT Article 11 and designating the United States of America; or

(ii) Complete as set forth in § 1.51(b); or

(iii) Entitled to a filing date as set forth in § 1.53(b) or § 1.53(d) and include the basic filing fee set forth in § 1.16; or

(iv) Entitled to a filing date as set forth in § 1.53(b) and have paid therein the processing and retention fee set forth in § 1.21(l) within the time period set forth in § 1.53(f).

37 C.F.R. § 1.78(a)(1).

NOTE: If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

WARNING: *If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. §§ 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. §§ 120, 121 or 365(c). (35 U.S.C. § 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. §§ 119, 365(a) or 365(b).) For a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.*

WARNING: *When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application* ***must*** *be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. § 1.78(a)(3).*

☒ The new application being transmitted claims the benefit of prior U.S. application(s). Enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

3. Papers Enclosed

A. Required for filing date under 37 C.F.R. § 1.53(b) (Regular) or 37 C.F.R. § 1.153 (Design) Application

23 Pages of specification

11 Pages of claims

9 Sheets of drawing

WARNING: ***DO NOT*** *submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. For comments on proposed then-new 37 C.F.R. § 1.84, see Notice of March 9, 1988 (1990 O.G. 57-62).*

NOTE: "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page . . ." 37 C.F.R. § 1.84(c)).

(complete the following, if applicable)

☐ The enclosed drawing(s) are photograph(s), and there is also attached a "PETITION TO ACCEPT PHOTOGRAPH(S) AS DRAWING(S)." 37 C.F.R. § 1.84(b).

☐ formal

☐ informal

B. Other Papers Enclosed

2 Pages of declaration and power of attorney (copy from parent case)

1 Pages of abstract

____ Other

4. Additional papers enclosed

☐ Amendment to claims

☐ Cancel in this applications claims _____ before calculating the filing fee. (At least one original independent claim must be retained for filing purposes.)

☐ Add the claims shown on the attached amendment. (Claims added have been numbered consecutively following the highest numbered original claims.)

☒ Preliminary Amendment

☐ Information Disclosure Statement (37 C.F.R. § 1.98)

☐ Form PTO-1449 (PTO/SB/08A and 08B)

☐ Citations

☐ Declaration of Biological Deposit

☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.

☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative

☐ Special Comments

☐ Other

5. Declaration or oath (including power of attorney)

NOTE: A newly executed declaration is not required in a continuation or divisional application provided that the prior nonprovisional application contained a declaration as required, the application being filed is by all or fewer than all the inventors named in the prior application, there is no new matter in the application being filed, and a copy of the executed declaration filed in the prior application (showing the signature or an indication thereon that it was signed) is submitted. The copy must be accompanied by a statement requesting deletion of the names of person(s) who are not inventors of the application being filed. If the declaration in the prior application was filed under § 1.47, then a copy of that declaration must be filed accompanied by a copy of the decision granting § 1.47 status or, if a nonsigning person under § 1.47 has subsequently joined in a prior application, then a copy of the subsequently executed declaration must be filed. See 37 C.F.R. §§ 1.63(d)(1)–(3).

NOTE: A declaration filed to complete an application must be executed, identify the specification to which it is directed, identify each inventor by full name including family name and at least one given name, without abbreviation together with any other given name or initial, and the residence, post office address and country or citizenship of each inventor, and state whether the inventor is a sole or joint inventor. 37 C.F.R. § 1.63(a)(1)–(4).

NOTE: "The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by § 1.62, except as provided for in § 1.53(d)(4) and § 1.63(d). If an oath or declaration as prescribed by § 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to § 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in § 1.17(i) is filed supplying or changing the name or names of the inventor or inventors." 37 C.F.R. § 1.41(a)(1).

☒ Enclosed

Executed by

(check **all** *applicable boxes)*

☒ inventor(s). (copy from parent case)

☐ legal representative of inventor(s). 37 C.F.R. §§ 1.42 or 1.43.

☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.

☐ This is the petition required by 37 C.F.R. § 1.47 and the statement required by 37 C.F.R. § 1.47 is also attached. See item 13 below for fee.

☐ Not Enclosed.

NOTE: Where the filing is a completion in the U.S. of an International Application or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

☐ Application is made by a person authorized under 37 C.F.R. § 1.41(c) on behalf of *all* the above named inventor(s).

(The declaration or oath, along with the surcharge required by 37 C.F.R. § 1.16(e) can be filed subsequently).

☐ Showing that the filing is authorized.
(not required unless called into question. 37 C.F.R. § 1.41(d))

6. Inventorship Statement

WARNING: *If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.*

The inventorship for all the claims in this application are:

☒ The same.

or

☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,

☐ is submitted.

☐ will be submitted.

7. Language

NOTE: An application including a signed oath or declaration may be filed in a language other than English. An English translation of the non-English language application and the processing fee of $130.00 required by 37 C.F.R. § 1.17(k) is required to be filed with the application, or within such time as may be set by the Office. 37 C.F.R. § 1.52(d).

☒ English

☐ Non-English

☐ The attached translation includes a statement that the translation is accurate. 37 C.F.R. § 1.52(d).

8. Assignment

☒ An assignment of the invention to FotoNation, Inc.

☒ is attached. A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached. (assignment of parent application as recorded)

☐ will follow.

NOTE: "If an assignment is submitted with a new application, send two separate letters-one for the application and one for the assignment." Notice of May 4, 1990 (1114 O.G. 77-78).

WARNING: *A newly executed "CERTIFICATE UNDER 37 C.F.R. § 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.*

9. Certified Copy

Certified copy(ies) of application(s)

Country	Appln. No.	Filed
Country	Appln. No.	Filed
Country	Appln. No.	Filed

from which priority is claimed

☐ is (are) attached.

☐ will follow.

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 C.F.R. § 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. § 120 is itself entitled to priority from a prior foreign application, then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

10. Fee Calculation (37 C.F.R. § 1.16)

A. ☒ Regular application

CLAIMS AS FILED

	Number filed		Number Extra		Rate	Basic Fee 37 C.F.R. § 1.16(a) ~~$690.00~~ 710.00
Total Claims (37 C.F.R. § 1.16(c))	27	− 20 =	7	×	$ 18.00	$126.00
Independent Claims (37 C.F.R. § 1.16(b))	4	− 3 =	1	×	80.00 $ ~~78.00~~	$ 80.00
Multiple dependent claim(s), if any (37 C.F.R. § 1.16(d))				+	$260.00	

☒ Amendment cancelling extra claims is enclosed.

☐ Amendment deleting multiple-dependencies is enclosed.

☐ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 C.F.R. § 1.16(d).

Filing Fee Calculation $ 916.00

B. ☐ Design application ($310.00—37 C.F.R. § 1.16(f))

Filing Fee Calculation $_____

C. ☐ Plant application
($480.00—37 C.F.R. § 1.16(g))

Filing fee calculation $_____

11. Small Entity Statement(s)

☒ Statement(s) that this is a filing by a small entity under 37 C.F.R. § 1.9 and 1.27 is (are) attached.

WARNING: *"Status as a small entity must be specifically established in each application or patent in which the status is available and desired. Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. The refiling of an application under § 1.53 as a continuation, division, or continuation-in-part (including a continued prosecution application under § 1.53(d)), or the filing of a reissue application requires a new determination as to continued entitlement to small entity status for the continuing or reissue application. A nonprovisional application claiming benefit under 35 U.S.C. § 119(e), 120, 121, or 365(c) of a prior application, or a reissue application may rely on a statement filed in the prior application or in the patent if the nonprovisional application or the reissue application includes a reference to the statement in the prior application or in the patent or includes a copy of the statement in the prior application or in the patent and status as a small entity is still proper and desired. The payment of the small entity basic statutory filing fee will be treated as such a reference for purposes of this section." 37 C.F.R. § 1.28(a)(2).*

WARNING: *"Small entity status must not be established when the person or persons signing the . . . statement can **unequivocally** make the required self-certification." M.P.E.P., § 509.03, 6th ed., rev. 2, July 1996 (emphasis added).*

(complete the following, if applicable)

☒ Status as a small entity was claimed in prior application 08 / 624,972, filed on March 28, 1996 from which benefit is being claimed for this application under:

35 U.S.C. § ☐ 119(e),
☒ 120,
☐ 121,
☐ 365(c),

and which status as a small entity is still proper and desired.

☒ A copy of the statement in the prior application is included.

Filing Fee Calculation (50% of **A, B** or **C** above)

$ 458.00

NOTE: Any excess of the full fee paid will be refunded if small entitiy status is established and a refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under § 1.136. 37 C.F.R. § 1.28(a).

12. Request for International-Type Search (37 C.F.R. § 1.104(d))

(complete, if applicable)

☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made at This Time

☐ Not Enclosed

☐ No filing fee is to be paid at this time.
(This and the surcharge required by 37 C.F.R. § 1.16(e) can be paid subsequently.)

☒ Enclosed

☒ Filing fee $ 458.00

☐ Recording assignment
($40.00; 37 C.F.R. § 1.21(h))
(See attached "COVER SHEET FOR ASSIGNMENT ACCOMPANYING NEW APPLICATION".) $ _____

☐ Petition fee for filing by other than all the inventors or person on behalf of the inventor where inventor refused to sign or cannot be reached
($130.00; 37 C.F.R. §§ 1.47 and 1.17(i)) $ _____

☐ For processing an application with a specification in
a non-English language
($130.00; 37 C.F.R. §§ 1.52(d) and 1.17(k)) $ _____

☐ Processing and retention fee
($130.00; 37 C.F.R. §§ 1.53(d) and 1.21(l)) $ _____

☐ Fee for international-type search report
($40.00; 37 C.F.R. § 1.21(e)) $ _____

NOTE: 37 C.F.R. § 1.21(l) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 C.F.R. § 1.53(f) and this, as well as the changes to 37 C.F.R. §§ 1.53 and 1.78(a)(1), indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of § 1.21(l) must be paid, within 1 year from notification under § 53(f).

Total fees enclosed $_____

14. Method of Payment of Fees

☒ Check in the amount of $ 458.00

☐ Charge Account No. _____ in the amount of $_____.

A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 C.F.R. § 1.22(b).

15. Authorization to Charge Additional Fees

WARNING: *If no fees are to be paid on filing, the following items should not be completed.*

WARNING: *Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.*

☒ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 03-3975 :

☐ 37 C.F.R. § 1.16(a), (f) or (g) (filing fees)

☐ 37 C.F.R. § 1.16(b), (c) and (d) (presentation of extra claims)

NOTE: *Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.*

☐ 37 C.F.R. § 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)

☐ 37 C.F.R. § 1.17(a)(1)-(5) (extension fees pursuant to § 1.136(a)).

☐ 37 C.F.R. § 1.17 (application processing fees)

NOTE: *". . .A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).*

☐ 37 C.F.R. § 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b))

NOTE: *Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. § 1.311(b).*

NOTE: *37 C.F.R. § 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . the issue fee. . . " From the wording of 37 C.F.R. § 1.28(b), (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.*

16. Instructions as to Overpayment

NOTE: ". . . Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

- [x] Credit Account No. 03-3975
- [ ] Refund

SIGNATURE OF PRACTITIONER

Reg. No. 32,243

David H. Jaffer
(type or print name of attorney)

PILLSBURY MADISON & SUTRO
2550 Hanover Street
P.O. Address
Palo Alto, CA 94304-1115

Tel. No. (650) 233-4500

Customer No. 24729

☒ **Incorporation by reference of added pages**

(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)

☒ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added 5

☐ Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added _____

☐ Plus added pages deleting names of inventor(s) named in prior application(s) who is/are no longer inventor(s) of the subject matter claimed in this application.

Number of pages added _____

☐ Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added _____

☐ **Statement Where No Further Pages Added**

(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item)

☐ This transmittal ends with this page.

Attorney's File No: 4423-03
Applicant or Patentee: Eran Steinberg, Hari Vasudev and Sumat Mehra
Serial/Patent Number:_____ Filed/Issued _____

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) AND 1.27(c) - SMALL BUSINESS CONCERN

I am ( ) the owner of the small business concern identified below;
(X) an official of the small business concern empowered to act on behalf of the concern identified below;

Name of Concern: EPix Imaging Systems Inc.
Address of Concern: 2953 Bunker Hill Lane, Suite 202
Santa Clara, CA 95054

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full time, part-time, or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention entitled: **INTELLIGENT CAMERA FLASH SYSTEM** by Eran Steinberg, Hari Vasudev and Sumat Mehra described in

(X) the specification filed herewith.
( ) application Serial No. _____ Filed _____.
( ) Patent No._____ Issued_____.

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9(d) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

*NOTE: Separate Verified Statements are required from each named person, concern, or organization having rights to the invention averring to their status as small entities (37 CFR 1.27)

NAME:_____
ADDRESS:_____
( ) INDIVIDUAL ( ) SMALL BUSINESS ( ) NONPROFIT ORG.

File No. 4423-03

I acknowledge my duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the Issue Fee or any Maintenance Fee due after the date on which status as a small entity is no longer appropriate (37 CFR 1.28(b)).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful, false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this Verified Statement is directed.

NAME OF PERSON SIGNING: Joe Mikelonis
TITLE: Vice President, Operations
ADDRESS OF PERSON SIGNING: 2953 Bunker Hill Lane, Suite 202
Santa Clara, CA 95954

SIGNATURE: _____ Date: 3/7/96

DHJ:RLF:0307z

Practitioner's Docket No. 29033-0269592 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Steinberg, et al.
Application No.: 08 / 624,972 Group No.: 2712
Filed: March 28, 1996 Examiner: Harrington, A.
For: INTELLIGENT CAMERA FLASH SYSTEM

Assistant Commissioner for Patents
Washington, D.C. 20231

NOTIFICATION OF FILING OF CONTINUING, DIVISIONAL OR CONTINUED PROSECUTION APPLICATION

Notification is hereby being made of the filing of a:

- ☒ continuation
- ☐ continuation-in-part
- ☐ divisional
- ☐ continued prosecution

application for this case

- ☒ concurrently herewith.
- ☐ on _____ .
  Date

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Diana Dearing
Signature

Date: November 20, 2000

Diana Dearing
(type or print name of person certifying)

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"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will ***not*** *be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.*

SIGNATURE OF PRACTITIONER

Reg. No. 32,243

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Practitioner's Docket No. 29033-0269592 **PATENT**

ADDED PAGES FOR APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED

NOTE: See 37 C.F.R. § 1.78.

17. Relate Back

WARNING: *If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. §§ 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. §§ 120, 121 or 365(c). (35 U.S.C. § 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. §§ 119, 365(a) or 365(b).) For a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.*

(complete the following, if applicable)

☒ Amend the specification by inserting, before the first line, the following sentence:

A. 35 U.S.C. § 119(e)

NOTE: "Any nonprovisional application claiming the benefit of one or more prior filed copending provisional applications must contain or be amended to contain in the first sentence of the specification following the title a reference to each such prior provisional application, identifying it as a provisional application, and including the provisional application number (consisting of series code and serial number)." 37 C.F.R. § 1.78(a)(4).

☐ "This application claims the benefit of U.S. Provisional Application(s) No(s).:

APPLICATION NO(S).:	FILING DATE
_____ /_____	_____ "
_____ /_____	_____ "
_____ /_____	_____ "

B. 35 U.S.C. §§ 120, 121 and 365(c)

NOTE: "Except for a continued prosecution application filed under § 1.53(d), any nonprovisional application claiming the benefit of one or more prior filed copending nonprovisional applications or international applications designating the United States of America must contain or be amended to contain in the first sentence of the specification following the title a reference to each such prior application, identifying it by application number (consisting of the series code and serial number) or international application number and international filing date and indicating the relationship of the applications. . . . Cross-references to other related applications may be made when appropriate." (See § 1.14(a)). 37 C.F.R. § 1.78(a)(2).

☒ "This application is a

- ☒ continuation
- ☐ continuation-in-part
- ☐ divisional

of copending application(s)

☒ application number 08/624,972 filed on March 28, 1996

☐ International Application _____ filed on

_____ and which designated the U.S."

NOTE: The proper reference to a prior filed PCT application that entered the U.S. national phase is the U.S. serial number and the filing date of the PCT application that designated the U.S.

NOTE: (1) Where the application being transmitted adds subject matter to the International Application, then the filing can be as a continuation-in-part or (2) if it is desired to do so for other reasons then the filing can be as a continuation.

NOTE: The deadline for entering the national phase in the U.S. for an international application was clarified in the Notice of April 28, 1987 (1079 O.G. 32 to 46) as follows:

"The Patent and Trademark Office considers the International application to be pending until the 22nd month from the priority date if the United States has been designated and no Demand for International Preliminary Examination has been filed prior to the expiration of the 19th month from the priority date and until the 32nd month from the priority date if a Demand for International Preliminary Examination which elected the United States of America has been filed prior to the expiration of the 19th month from the priority date, provided that a copy of the international application has been communicated to the Patent and Trademark Office within the 20 or 30 month period respectively. If a copy of the international application has not been communicated to the Patent and Trademark Office within the 20 or 30 month period respectively, the international application becomes abandoned as to the United States 20 or 30 months from the priority date respectivley. These periods have been placed in the rules as paragraph (h) of § 1.494 and paragraph (i) of § 1.495. A continuing application under 35 U.S.C. 365(c) and 120 may be filed anytime during the pendency of the international application."

☐ "The nonprovisional application designated above, namely application _____ / _____, filed _____, claims the benefit of U.S. Provisional Application(s) No(s).:

APPLICATION NO(S).:	FILING DATE
_____ / _____	_____ "
_____ / _____	_____ "
_____ / _____	_____ "

☐ Where more than one reference is made above, please combine all references into one sentence.

18. Relate Back—35 U.S.C. § 119 Priority Claim for Prior Application

The prior U.S. application(s), including any prior International Application designating the U.S., identified above in item 17B, in turn itself claim(s) foreign priority(ies) as follows:

Country	Appln. no.	Filed on

The certified copy(ies) has (have)

☐ been filed on _____, in prior application 0 /_____, which was filed on _____.

☐ is (are) attached.

WARNING: *The certified copy of the priority application that may have been communicated to the PTO by the International Bureau may not be relied on without any need to file a certified copy of the priority application in the continuing application. This is so because the certified copy of the priority application communicated by the International Bureau is placed in a folder and is not assigned a U.S. serial number unless the national stage is entered. Such folders are disposed of if the national stage is not entered. Therefore, such certified copies may not be available if needed later in the prosecution of a continuing application. An alternative would be to physically remove the priority documents from the folders and transfer them to the continuing application. The resources required to request transfer, retrieve the folders, make suitable record notations, transfer the certified copies, enter and make a record of such copies in the Continuing Application are substantial. Accordingly, the priority documents in folders of international applications that have not entered the national stage may not be relied on. Notice of April 28, 1987 (1079 O.G. 32 to 46).*

19. Maintenance of Copendency of Prior Application

NOTE: The PTO finds it useful if a copy of the petition filed in the prior application extending the term for response is filed with the papers constituting the filing of the continuation application. Notice of November 5, 1985 (1060 O.G. 27).

A. ☐ Extension of time in prior application

*(This item **must** be completed and the papers filed **in the prior application**, if the period set in the prior application has run.)*

☐ A petition, fee and response extends the term in the pending **prior** application until _____.

☐ A **copy** of the petition filed in prior application is attached.

B. ☐ Conditional Petition for Extension of Time in Prior Application

(complete this item, if previous item not applicable)

☐ A conditional petition for extension of time is being filed in the pending **prior** application.

☐ A **copy** of the conditional petition filed in the prior application is attached.

20. Further Inventorship Statement Where Benefit of Prior Application(s) Claimed

(complete applicable item (a), (b) and/or (c) below)

(a) ☒ This application discloses and claims only subject matter disclosed in the prior application whose particulars are set out above and the inventor(s) in this application are

- ☒ the same.
- ☐ less than those named in the prior application. It is requested that the following inventor(s) identified for the prior application be deleted:

_____

(type name(s) of inventor(s) to be deleted)

(b) ☐ This application discloses and claims additional disclosure by amendment and a new declaration or oath is being filed. With respect to the prior application, the inventor(s) in this application are

- ☐ the same.
- ☐ the following additional inventor(s) have been added:

_____

(type name(s) of inventor(s) to be added)

(c) The inventorship for all the claims in this application are

- ☒ the same.
- ☐ not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made
  - ☐ is submitted.
  - ☐ will be submitted.

21. Abandonment of Prior Application *(if applicable)*

☐ Please abandon the prior application at a time while the prior application is pending, or when the petition for extension of time or to revive in that application is granted, and when this application is granted a filing date, so as to make this application copending with said prior application.

NOTE: According to the Notice of May 13, 1983 (103, TMOG 6-7), the filing of a continuation or continuation-in-part application is a proper response with respect to a petition for extension of time or a petition to revive and should include the express abandonment of the prior application conditioned upon the granting of the petition and the granting of a filing date to the continuing application.

22. Petition for Suspension of Prosecution for the Time Necessary to File an Amendment

WARNING: *"The claims of a new application may be finally rejected in the first Office action in those situations where (A) the new application is a continuing application of, or a substitute for, an earlier application, and (B) all the claims of the new application (1) are drawn to the same invention claimed in the earlier application, and (2) would have been properly finally rejected on the grounds of art of record in the next Office action if they had been entered in the earlier application." M.P.E.P., § 706.07(b), 7th ed.*

NOTE: Where it is possible that the claims on file will give rise to a first action final for this continuation application and for some reason an amendment cannot be filed promptly (e.g., experimental data is being gathered) it may be desirable to file a petition for suspension of prosecution for the time necessary.

(check the next item, if applicable)

☐ There is provided herewith a Petition To Suspend Prosecution for the Time Necessary to File An Amendment (New Application Filed Concurrently)

23. Small Entity (37 C.F.R. § 1.28(a))

☒ Applicant has established small entity status by the filing of a statement in parent application 08/624,972 on March 28, 1996

☒ A copy of the statement previously filed is included.

WARNING: *See 37 C.F.R. § 1.28(a).*

WARNING: *"Small entity status must not be established when the person or persons signing the . . . statement can **unequivocally** make the required self-certification." M.P.E.P., § 509.03, 7th ed. (emphasis added).*

24. NOTIFICATION IN PARENT APPLICATION OF THIS FILING

☒ A notification of the filing of this
(check one of the following)

☒ continuation

☐ continuation-in-part

☐ divisional

is being filed in the parent application, from which this application claims priority under 35 U.S.C. § 120.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Steinberg et al. **Docket No.** 29033-026-9592
Serial No.: Continuation of 08/624,972
For: **INTELLIGENT CAMERA FLASH SYSTEM**

PRELIMINARY AMENDMENT

Commissioner of Patents and Trademarks
Washington, D.C. 20231

Dear Sir:

In response to the Office Action in the parent application dated January 24, 2000, Applicants respectfully request that the claims be amended as follows:

In the Claims

Cancel claims 1, 9-10, 14, 17, and 23-25.

In claim 2, line 1: Change "claim 1" to --claim 28--.

In claim 3, line 1: Change "claim 1" to --claim 28--.

In claim 4, line 1: Change "claim 1" to --claim 28--.

In claim 5, line 1: Change "claim 1" to --claim 28--.

In claim 7, line 1: Change "claim 1" to --claim 28--.

In claim 15, line 1: Change "claim 14" to --claim 29--.

In claim 16, line 1: Change "claim 14" to --claim 29--.

In claim 18, line 1: Change "claim 18" to --claim 30--.

In claim 19, line 1: Change "claim 18" to --claim 30--.

In claim 20, line 1: Change "claim 18" to --claim 30--.

In claim 21, line 1: Change "claim 18" to --claim 30--.

In claim 22, line 1: Change "claim 18" to --claim 30--.

In claim 26, line 1: Change "claim 26" to --claim 31--.

28. (new) A flash method operable each time a flash picture is taken with a digital camera, said method comprising performing the following steps with the camera each time the camera takes a flash picture:

a) activating a flash with a flash energy lower than the energy normally required for an acceptable final flash energy level for achieving a correct exposure;

b) grabbing an image of a subject located a distance from said camera to create image intensity data;

c) analyzing said image intensity data to determine a flash degree of exposure, wherein the analyzing does not require knowledge of said distance;

d) calculating a subsequent flash energy level to achieve a corrected degree of exposure;

e) repeating steps (a) through (d) until the acceptable final flash energy level for achieving a correct exposure is determined; and

f) activating a flash at the determined acceptable final flash energy;

wherein each of steps (a) through (f) is performed automatically each time the camera takes a flash picture.

29. (new) A flash method operable each time a flash picture is taken with a digital camera, said method comprising performing the following steps with the camera each time the camera takes a flash picture:

a) activating a flash with a first flash energy lower than the energy normally required for an acceptable final flash energy level;

b) grabbing a first image of a subject located a distance from said camera to create first image intensity data;

c) analyzing said first image intensity data to determine a first degree of exposure, wherein the analyzing does not require knowledge of said distance;

d) scaling said first flash energy to determine a final flash energy level; and

e) activating said flash at said final flash energy level for taking a picture;

wherein each of steps (a) through (e) is performed automatically each time the camera takes a flash picture.

30. (new) A flash apparatus operable each time a flash picture is taken with a digital camera, said apparatus comprising:

a) means for activating a flash with a flash energy lower than the energy normally required for an acceptable final flash energy level for achieving a correct exposure;

b) means for grabbing an image of a subject located a distance from said camera to create image intensity data;

c) means for analyzing said image intensity data to determine a flash degree of exposure, wherein the analyzing does not require knowledge of said distance;

d) means for calculating a subsequent flash energy level to achieve a corrected degree of exposure;

e) means for repeating steps (a) through (d) until an acceptable final flash energy level for achieving a correct exposure is determined; and

f) means for activating a flash at the determined acceptable final flash energy;

wherein the apparatus is integrated with the camera and operates automatically each time the camera takes a flash picture

31. (new) A flash apparatus operable each time a flash picture is taken with a digital camera, said apparatus comprising:

a) means for activating a flash with a first flash energy lower than the energy normally required for an acceptable final flash energy level;

b) means for grabbing a first image of a subject located a distance from said camera to create first image intensity data;

c) means for analyzing said first image intensity data to determine a first degree of exposure, wherein the analyzing does not require knowledge of said distance;

d) means for scaling said first flash energy to determine a final flash energy; and

e) means for activating said flash at said final flash energy level for taking a picture;

wherein the apparatus is integrated with the camera and operates automatically each time the camera takes a flash picture.

REMARKS

Applicants have cancelled claims 9-10 and 23-24, which were allowed in the parent case. Claims 1, 14, 17, and 25 are also cancelled, and claims 28-31 are presented. Claims 28, 29, 30, and 31 correspond to claims 1, 14, 17, and 25, respectively, of the parent case (as most recently amended). For convenience, we have shown changes to claims 28-31 as if amending former claims 1, 14, 17, and 25, as pending prior to the Office Action in the parent case dated January 24, 2000.

Section 102 Rejection

Item 1 of the Office Action dated January 24, 2000, in the parent case states that

> "*Ota discloses flash energy level control can be determined by distance information or color information,*"

and

> "*it would have been obvious to one of ordinary skill in the art at the time the invention was made that flash control does not have to be distance based calculation.*"

Applicant respectfully traverses this argument. Ota does not disclose the use or control of a flash for taking a picture. Ota only discloses control of exposure by adjusting the iris and shutter (column 13, lines 35-39). Applicants' claims describing flash control are therefore not described by Ota.

Item 2 of the Office Action rejects claims 4, 13, 16 and 27 under 35 U.S.C. 112, 2nd paragraph, as indefinite because "*the Examiner is unclear to applicant's intended meaning.*" The use of the terminology "minimum flash energy level" is considered unclear since the final flash energy is stated as higher than the previous flash energy in the base claims. Applicants acknowledge the need to clarify the claims and have amended claim 28 accordingly to change "energy required" in line 6 to "energy normally required." This change avoids claiming that the final flash is higher in energy than the preliminary flashes. The "minimum" flash of claims 4, 13, 16 and 27 is a minimum preset value that is used when all of the pre-flashes indicate an over-exposed condition. Applicants believe this amendment clarifies claims 4, 13, 16 and 27, and that they are now distinguishable over Yamamoto and Ota and are allowable.

Item 3 of the Office Action dated January 24, 2000, in the parent case rejects claims 1-5, 7, 8, 11, 12-20, 22, and 25-27 under 35 U.S.C. 103(a) as being unpatentable over Yamamoto in view of Ota. Regarding independent claim1 of the parent claim (claim 28 as presented herein), Yamamoto does not disclose a calibration that occurs each time a picture is taken. Yamamoto's

process is a one-time factory calibration and requires distance information. Thereafter, for each picture taken, the Yamamoto camera measures the distance to the subject and refers to the factory calibration to set the flash energy. No pre-flashes are used. Applicants are unaware of a camera that is known to automatically adjust a flash by using pre-flashes and analyzing corresponding image data prior to taking each picture. Ota does not teach the use of a flash and controlling a flash to achieve proper exposure. Ota teaches adjusting the iris and shutter. Applicants respectfully request specific reference to publications or products prior to the filing date of the parent application that perform the processes according to claims 28-31 (claims 1, 14, 17, and 25 of the parent case) in order to verify the corresponding statements in the Office Action. Applicants believe that independent claims 28-31 as amended are clarified and are now allowable.

Regarding independent claim 14 of the parent case (claim 29 as presented herein), the Office Action states

> *"Since grabbing an image means taking a picture, the steps are done during taking a picture."*

In explanation, when a consumer takes a picture with Yamamoto's camera, the camera measures the distance to the subject and with this information refers to a factory calibration chart in camera memory which gives the required flash energy data from which the camera activates the flash. This is an entirely different procedure from that defined by any of the independent claims 28-31. Yamamoto's camera does not use a pre-flash and analyze corresponding image data to determine a flash energy level when a picture is taken by a consumer. The only repetitious use of flashes in the Yamamoto disclosure are those required to determine the factory calibration chart, which is a one lens manually assisted process performed at the factory. In explanation, the Yamamoto process is directed to a one-lens factory calibration of the camera, and therefore does not meet the requirement of claim 29 which requires that the process be done each time a flash picture is

taken. In order to further distinguish the independent claims 28-31 from Yamamoto, Applicants have added the limitation that the steps be performed automatically. The calibration procedure of Yamamoto requires operator's invention in addition to pressing a shutter button.

Regarding independent claims 17 and 25 of the parent case (claims 30 and 31 as presented herein) , these claims are apparatus claims corresponding to the method claims 1 and 14 of the parent case. As a result, the Office Action's reasons for rejection are essentially the same as those given in reference to claims 1 and 14 of the parent case. Applicants' response is also the same as stated above in reference to claims 1 and 14 of the parent case (claims 28 and 29 as presented herein). The Yamamoto camera does not contain apparatus for performing pre-flashes and evaluating corresponding image data to determine a flash energy each time a picture is taken.

In summary of the above, Applicants believe that independent claims 28-31 are now allowable, and that the remaining dependent claims are also allowable in adding further limitation to allowable claims.

CONCLUSION

Applicants respectfully request a Notice of Allowance. If any further questions should arise prior to allowance, the Examiner is invited to contact the undersigned at the number set forth below.

Respectfully submitted,

David H. Jaffer
Reg. No. 32,243

PILLSBURY MADISON & SUTRO
2550 Hanover Street
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(650) 233-4510

CERTIFICATE OF MAILING

No. EL596836594US

I hereby certify that this correspondence is being deposited with the United States Postal Service on the date shown below with sufficient postage as Express Mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231 on 11-20-00 by DIANA DEARING.

Diana Dearing

Specification

INTELLIGENT CAMERA FLASH SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to electronic digital cameras, and more particularly to a digital camera using a pre-flash in combination with digital camera image acquisition apparatus and a processor for creating a histogram to determine an optimum flash power controlled through calculation of flash capacitor voltage.

Brief Description of the Prior Art

Prior art cameras have used many different techniques to achieve optimum exposure, from hand held light meters to built in automatic exposure systems with flash. One method of controlling exposure is based on "through the lens" flash control in which the flash is terminated when sufficient light is collected by a photo receptor in the camera. Another method uses an infrared photo diode to measure the light. The advantage of using infrared is that in the infrared zone, light is more evenly reflective as a function of color in the visible spectrum. These methods are all based on an average (integration) over the entire image, and are not able to separate out important image areas for priority in setting the amount of light for exposure. For example, a combination of a close image and a distant background will result in a "washed out" foreground. Since primary subjects are often in the foreground, this is a serious problem in automatic exposure systems. These exposure control systems also require a very fast electronic switching device for a fast flash and a separate photo receptor which add complexity and cost to the system. The infrared receptor also has a problem in that the light measured

is only a monochromatic estimation of the scenery. This estimation may be close in some cases, but in others, it accentuates the problem of film/CCD metamerism, a condition where different wavelengths in a scene are improperly recorded.

In Coltman et al., U.S. Patent No. 4,998,128 the reflectivity of a subject is determined by pulsing a flash unit for predetermined short period of time. The light is detected by both visible and infrared light detectors, the outputs of which are integrated and used to select an optimum aperture and speed setting for taking the picture. In Taylor, U.S. Patent No. 4,066,884 an adjustable filter is used to vary the light intensity from an electronic flash unit, the degree of adjustment being empirically determined for a particular type of camera, in this case cameras designed for use with explosive flashbulbs which have relatively long duration of light intensity. The problem with the electronic flash unit when used with cameras having automatic exposure adjustment is that the time duration of the electronic flash is too short for the automatic exposure system to work. In Winter, U.S. Patent No. 4,549,801, an electrically operated flash camera employs an infrared flash reflected light signal stored in a single memory storage to control focus and aperture. In Ishida, U.S. Patent No. 4,256,995, an electronic flash is disclosed which is capable of emitting light for a longer duration of time so as to allow automatic exposure control camera systems to function. Kabayashi et al., U.S. Patent No. 4,717,934 discloses a flash used prior to image acquisition to determine the amount of flash required for an adequate exposure. This is done by detecting and integrating light radiated directly from the flash, and integrating the reflected light from the object. The flash power is provided by a separate capacitor from the capacitor used for the main flash.

In Coltman, the pre-flash system functions independently from the camera image acquisition apparatus, depending on a predetermined look up table. The accuracy of this method is

limited to the exactness of the correlation between the look up table and the actual setting. The mechanical adjustment device of Taylor for control of the flash intensity is dependent on the skill of the operator in knowing where to set the flash cover. In Winter, the burden of adjusting for exposure is placed entirely on the camera aperture and shutter speed. No attempt is made to control the amount of flash. The device of Ishida similarly does not use control of the flash time as an aid in achieving proper exposure but simply provides a flash of long duration, allowing conventional camera automatic exposure systems to function as if the lighting were ambient. This system would consume larger amounts of flash power than what would otherwise be required for proper exposure. The device of Kabayashi requires a separate capacitor for pre-flashing, which involves extra cost and space.

It is apparent from the above references that an improved camera is desirable, that conserves flash power and minimizes cost and space. Also, an improved camera would provide a method for evaluating light from different parts of an image to determine optimum exposure of particularly selected areas, this being a particular problem when objects are at various distances from the camera and when they are in contrast to each other. Such a camera would be a significant improvement over the prior art.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an improved digital camera having provision for determining optimum flash energy for illumination of a selected area of an image.

It is a further object of the present invention to provide an improved digital camera using reduced energy flash illumination to determine optimum full flash energy.

It is another object of the present invention to provide an improved digital camera having a flash system providing a series

of lower power flashes prior to a final flash utilizing a single capacitor and providing for optimum use of flash energy.

It is another object of the present invention to provide an improved digital camera that uses the image acquisition apparatus to determine optimum camera exposure parameters from a low energy flash prior to a final flash.

It is a further object of the present invention to provide a camera having a method of estimating an acquired image from data collected from low energy pre-flashes.

It is a still further object of the present invention to provide a camera that determines flash exposure based on center weight subsampling.

It is another object of the present invention to provide a method for determining the energy of sequential flashes (strobes) based on the discharge curve of the flash capacitor in a digital camera.

It is a further object of the present invention to provide a method of determining flash exposure based on samplings of an image luminous histogram.

Briefly, a preferred embodiment of the present invention includes an intelligent flash system for a digital camera having components including an image optical pickup, an interface circuit, a flash unit and a processor. Upon activation of the camera, ambient lighting conditions are evaluated and if flash energy is required, a first low energy flash is radiated, the reflected light received by the optical pickup having a multiplicity of pixels, and the output of the pixels converted to image intensity data by the interface circuit. The processor samples the image intensity data, weighing the center image area more heavily, and creates a histogram plot of quantity of pixels v.s. intensity, and separates the plot into a bar graph from which a determination of exposure is obtained. The histogram is then used to calculate a multiplicative scaling factor used to multiply the first flash energy as an estimate of a final flash energy for correct exposure. Conditions of extreme over and

under exposure result in the activation of a second flash at an adjusted energy level. The image data of the second flash is then analyzed and the exposure compared with the result of the first flash. A final determination of flash energy is then made based upon the results.

An advantage of the present invention is the provision of a flash system for a digital camera that provides optimum flash energy.

A further advantage of the present invention is that it provides a flash system that uses reduced energy flashes in the determination of exposure, thus conserving total flash energy.

Another advantage of the present invention is the provision of a flash system that conserves flash energy and operates from a single flash capacitor.

A further advantage of the present invention is the use of the image acquisition optics to determine exposure, thus providing increased accuracy and a reduced parts cost.

It is a further advantage of the present invention to provide a flash system that determines exposure based on center weight sampling, giving greater importance in exposure determination to a more important area of the image.

IN THE DRAWINGS

Fig. 1 shows a block diagram of a digital camera according to the present invention;

Fig. 2 is an overall block diagram of the intelligent flash system;

Fig. 3 is a block diagram showing further details of the method of achieving correct exposure;

Fig. 4A is a sample image area illustrating the selection of a selection of a preferred object area;

Fig. 4B illustrates the weighted sampling of the preferred object area of Fig. 3A;

Fig. 5 is a simplified array of pixel intensities;

Fig. 6A is a simplified histogram and bar graph based on the image intensity data of Fig.4;

Fig. 6B is a table of the quantities of pixels and their intensities before and after scaling;

Fig. 7 is a block diagram illustrating the method of exposure determination using the bar graph;

Fig. 8 is a more realistic histogram before and after scaling;

Fig. 9 is a block diagram showing the method of determining a scaling factor;

Fig. 10 is a block diagram illustrating the determination of flash capacitor cutoff voltage;

Fig. 11 is a schematic of a flash circuit; and

Fig. 12 is a detailed block diagram showing the analysis of the image resulting from activation of a second flash.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A typical camera system in which the method and apparatus of the present invention is employed is shown in Fig. 1, wherein a digital camera 10 is illustrated having a multiprocessor 12 activated by shutter activator 14 through line 16, and communicating through bus 18 with image interface circuit 20. The multiprocessor further communicates with memory 22 through bus 24 and interconnects with the flash unit 26 through bus 28. Image optical pick-up 30 is interconnected to the image interface circuit 20 through bus 32. A power supply 34 is shown for providing electrical energy to the various circuit components through lines not shown.

In response to the shutter activator 14, light 36 from an image to be recorded is received by the image optical pick-up 30 and sent via bus 32 to the image interface circuit 20 which communicates with the pick-up 30 and processor 12 to provide digital image intensity data corresponding to the light 36. Further details of the pick-up 30 and circuit 20 are not necessary for an understanding of the present invention. Those

skilled in the art of digital cameras will know how to fabricate the light to digital data apparatus.

According to Fig. 2, a user can select (block 38) one of two modes, including an AUTO MODE (block 40) or a MANDATORY FLASH MODE (block 42). In either of the two modes, Auto or Mandatory Flash, the processor 12 is configured to respond to the activator 14 by sampling and analyzing the ambient light (blocks 44 and 46) to determine if it is adequate. In the Auto Mode, if the ambient light is found (block 48) to be adequate, the picture is taken without a flash (block 50). If the ambient light is not adequate and a flash is needed (52) the camera parameters (block 54) are set for what is defined as a "full flash mode" at which point the flash is adjusted for optimum exposure and the picture is taken (block 56). This process includes a series of one or more flashes applied to determine an optimum flash energy for proper exposure. The first flash is preset at a lower energy generally considered to result in "under" exposure. If the light from the first flash is adequate for an analysis, the image is analyzed and an estimate of a proper flash energy for a correct exposure is made and the picture is taken at this flash energy. If the light from the first flash is not sufficient for an analysis, a second flash is activated at a higher energy level. The preferred embodiment provides for a maximum of two flashes prior to a flash activated to take a picture. Alternate embodiments however can use any number of flashes prior to the final flash. When sufficient light for an analysis is provided by a flash, the processor 12 scales the flash energy level to determine an estimated flash energy level for correct exposure and the camera takes the picture at this energy level.

In the preferred embodiment, if the second flash energy level is insufficient for an analysis, i.e. resulting in either extreme under or over exposure, no further analysis is done. The picture is then taken (block 58) at a minimum flash energy level if the second flash caused extreme over exposure or at a

maximum flash energy level if the result of the second flash was extreme under exposure.

The mandatory flash mode 42 results in the use of a flash regardless of the ambient lighting conditions, the purpose being to use the flash to fill shadows, such as on a subject person's face caused by bright sunlight. If the evaluation of ambient light (46) results in a determination (60) that a flash is needed (62), the camera parameters are set (54) as described above and the process continues according to the operations defined for blocks 56 and 58. If the ambient light is adequate, camera parameters are set 66 to reduce the ambient light input to the camera. The parameter adjustments in this case could include an increase in speed and/or a reduction in the camera aperture. The correct flash power is then determined and the picture is taken as explained above according to the operations associated with blocks 56 and 58.

The deliberate use of a low energy first flash is for the purpose of conserving flash capacitor energy so that the flash capacitor will subsequently have enough energy for a proper final flash without recharging. This method saves energy and eliminates the need for a separate flash capacitor for the flashes prior to the final flash.

Referring again to Fig. 1, the light 36 from the flash is reflected from an object, received by the pick-up 30 and converted to a multiplicity of analog signals, each corresponding to one pixel in an array. These analog signals are then processed into digital image intensity data by the circuit 20 and sent to the processor 12. This process of conversion of the light to image intensity data will be termed "grabbing the image" in the following text.

A more detailed description of the process of analyzing the image to determine exposure and a proper final flash will now be given. This description is somewhat complicated in the fact that the process is generally applicable to the two sources of light, i.e. from ambient or other secondary light and from a

flash, as indicated in blocks 44, 46 and 56. In order to avoid having to repeat a lengthy description, the following analysis will generally apply to both situations, with emphasis on the use of flash energy. The differences will be explained as the description proceeds.

In general, the camera 10 responds to the low energy first flash, or to a first ambient light sample by grabbing a first image (or first ambient image to distinguish the use of ambient light) and creating first image intensity (or first ambient image intensity) data. The processor 12 then constructs a first histogram and first bar graph from sampled first image intensity data, and from an analysis of this data determines a first degree of exposure, i.e. whether the object needs more or less light or whether the exposure is correct. In the above, the terminology generally also applies to an ambient/secondary light source. The terminology can be distinguished from the use of flash energy by replacing the terms first histogram, first bar graph and first degree of exposure with first ambient histogram, first ambient bar graph and first ambient degree of exposure. These distinctions will now be implied in the following descriptions without repetitiously making note of them.

If the amount of light (first degree of exposure) is correct, a second flash or sampling is bypassed and the first flash energy level (or camera parameters for ambient light) is used to take the picture. In the case of ambient light (blocks 44 or 46), an automatic adjustment of camera parameters (speed, F-stop) would be made if the degree of exposure were not adequate. If the exposure is adequate, the picture is taken with ambient light and original parameters. If the exposure is not correct, but a meaningful histogram was created in the analysis, i.e., if the image was not greatly over or under exposed, a scaling procedure is performed on the sampled first image intensity data. This scaling procedure is performed by the processor by finding a first scaling factor to the first sampled intensity data so as to cause a predetermined percentage

(.5% preferred) of the pixels to be above the saturation value of the image optical pickup (preferably a CCD). This scaling is accomplished by multiplying the sampled first image intensity data by the first scaling factor and reconstructing and re-analyzing the histogram to determine the number of pixels with intensities exceeding the saturation value. Upon finding the proper scaling factor in the case when the camera is analyzing an image from a flash, the processor uses this factor as an energy scaling factor, by which to multiply the first flash energy level to obtain an estimated correct final flash energy level. The picture is then taken with this estimated final flash energy. If the light source is ambient with no flash, the scaling factor is used with a look-up table or as an appropriate factor to determine an adjusted set of camera parameters. If the result from ambient light is a condition of extreme under exposure to such an extent that no camera speed or aperture adjustment will correct it, the camera automatically shifts to the full flash mode (block 54) and the above process is activated as described in relation to the use of a first and second flash.

In either the case of ambient or flash light sources, the above described scaling is not performed if the degree of exposure is extremely under exposed (low clipping) or extremely over exposed (high clipping), since a meaningful histogram cannot then be prepared. If a meaningful histogram is not obtained from the first flash, due to either extreme under exposure (low clipping) or extreme over exposure (high clipping), a second flash at a second flash energy level is activated, the second flash energy level being at an adjusted fraction of the first flash. If the first degree of exposure is extremely under exposed (low clipping), the second flash energy level is adjusted to a greater energy level. If the first degree of exposure is extremely over exposed (high clipping), the second flash energy level is adjusted to a lower energy level. A second image of the object is then grabbed, and second

image intensity data is created from which sampled second image intensity data is taken and a second histogram and second bar graph are created therefrom. The second histogram and second bar graph are then analyzed and a second degree of exposure determined. If high or low clipping are still occurring, the flash energy is minimized or maximized respectively and a picture is taken. If the exposure is correct, the flash is again activated at the second flash energy level to take the picture. In the case of under or over exposure, i.e., moderate under or over exposure not resulting in clipping, a second scaling factor is determined and used as a multiplicative scaling factor on the second flash energy to determine an estimated correct final flash energy. The use of the term "under exposure" and "over exposure" in the following text will generally indicate moderate "over" or "under" exposure, rather than extreme under or over exposure which will be alternatively termed low and high clipping. The above description using a maximum of two flashes prior to a final flash is the preferred embodiment, however, alternate embodiments include any number of flashes prior to a final flash and are included in the invention.

The operation described in Fig. 2 can be more fully understood through reference to Fig. 3. The blocks 68-88 included in block 90 give added detail to the operation of blocks 44-48, and 52-66 in Fig. 2. This determination of exposure in blocks 44 and 46 of Fig. 2 uses ambient light as the light sources. Block 56 uses a flash. In Fig. 3, block 90 more fully describes the activity of determining the exposure. Block 68 indicates the activation of the light source, which is either a flash or a sampling of ambient light.

The image is then grabbed (block 70) i.e., detected by the optical pick-up 30 (Fig. 1) and processed by the interface circuit 20 to digital image intensity data. The image intensity data is then analyzed to determine a degree of exposure. This analysis involves the following operations in blocks 71 and 72

including sampling of the image intensity data in a selective manner (block 71) in order to weigh more heavily the data representing the primary object area. This area is usually considered to be near the center of the image, and such sampling is to be considered part of the preferred embodiment; however, the processor 12 could be programmed to weigh other areas more heavily and they are included in the spirit of the invention.

The sampled image data is then analyzed to determine the exposure (block 72), and the activity is directed accordingly. If the condition is extreme overexposure, resulting in high clipping where the large majority of pixels are at the high end of the intensity range, the process is directed to block 74. If the condition is extremely under exposed, the process continues in block 76. Simple over or under exposure not resulting in clipping are directed to blocks 78 and 80 respectively, and if the exposure is correct, activity continues at block 92.

The operations of blocks 74, 76, 78 and 80 all involve calculating either a subsequent flash energy or a subsequent set of camera parameters such as speed and aperture to sample a corrected amount of light to achieve a correct exposure. The calculation is either for a subsequent flash or ambient sample to be analyzed, or a final flash energy level or set of parameters for a final sample of ambient light to take the picture. In the case of severe over exposure the operations indicated by block 74 involve setting parameters to determine the energy of a second flash when a flash is the light source, or re-setting the camera parameters such as speed and aperture if ambient light is the source. For the flash case, block 74 indicates one half of the energy of the first flash, but some other fraction could be used as well. Similarly, if the condition is extremely underexposed (low clipping) where nearly all of the pixel intensities are near the low end of the intensity scale, parameters are set to direct a second flash at higher energy (block 76). Although block 76 indicates doubling the energy, some other factor could be used.

If the condition is merely overexposed i.e. over exposed to a lesser degree and a detailed histogram can be prepared, the image data is adjusted (block 78) by a scaling factor until the histogram shows preferably .5% of the intensity data exceeding a predetermined intensity level, at which point the corresponding scaling factor is used to scale down the first flash power, or is used to determine adjusted camera parameters.

If the result of the analysis indicates a similar condition of under exposure to a lesser degree than low clipping so that a histogram can be created (block 80), the processing is similar to the description above for overexposure. The scaling factor for under exposure would be greater than unity, which would increase the flash energy.

If the first flash or ambient light sample results in a correct exposure 82, the processor proceeds directly to block 92 and the flash is activated at a power level equal to the first flash energy, or in the case of ambient light, the same quantity of light is admitted/sampled again.

In the above cases involving over exposure 78, under exposure 80, and correct exposure 82, a second flash or sampling of ambient light is not required. When the analysis shows correct exposure, the corresponding flash energy is again activated or the sampled quantity of ambient/secondary light is again sampled (block 92), the image grabbed 94 and recorded 96. In the cases of high clipping 74 and low clipping 76, either a second flash is activated 84 at an adjusted energy level, or a second ambient light sample is admitted followed by the grabbing of the image 86 and further analysis 88 and decision making in order to arrive at a correct flash energy or setting of camera parameters. In the preferred embodiment, a maximum of two flashes occur before a final flash is activated to take the picture. A larger number of flashes prior to the final flash are also included in the invention and this is indicated by arrows 85 and 87 showing the operations from block 70 to 84 repeated. This repetition can be any number of times according

to the programming. For example, smaller increments of flash energy adjustment in blocks 74 and 76 could be used, which could require more repetitions of analysis and adjustment to arrive at a useable flash energy from which to scale (block 78, 80) a final flash energy, or more adjustments of flash energy could be done before a final determination that the minimum or maximum flash energy should be used. Following the operation of block 88, determining optimum flash energy or camera parameters, the light source (flash or ambient/secondary) is activated 98, the image grabbed 100 and recorded 102. This is all indicated by block 88, the details of which will be fully described in the following specification in reference to the figures of the drawing.

The "sample image" block 71 of Fig. 3 is more fully described with reference to Figs. 4a and 4b. The image optical pick-up 30, such as a charged coupled device (CCD), contains thousands of individual receptors, i.e. pixels (picture elements). An analysis of the output of each of these elements would be a very expensive project, and for this reason the pixels are sampled (block 71). For example, suppose there were 300,000 pixels. In order to bring the analysis down to a more economical level, 1000 of the pixels could be selected from the 300,000. The number of pixels and the following numbers and graphs are given by way of illustration of the method and apparatus of the present invention, and are not to be considered as limiting, since any number of pixels or any sample quantity could apply. In the example selected for illustration, a significantly greater number of pixels are sampled from the center area relative to the edges since the center of the image usually contains the primary subjects of the photography. This selective sampling gives greater weight to the lighting of the more-important area of the image. For example, suppose square 104 of Fig. 4 is the total area of an image. For illustration, it is partitioned into a center region 106 and an edge region 108. The camera can be set up to consider the center region 106

as being of greater importance. The area is arbitrarily selected for illustration to contain 4% of the pixels. The camera in this case would then weigh light intensity from the center 106 more heavily than the edge region 108, by sampling a larger number of pixels per unit area from the center region than from the edge region. For example, Fig. 4b represents a weighted sampled image of image 104. The original region 106 is now represented by region 110 occupying 25% of the total sampled image and region 108 represented by sampled region 112 in Fig. 4b. In other words, a particular area of the image can be over sampled in order to weigh it as more important in determining what is a correct exposure. Although the preferred embodiment involves sampling the center region more heavily, alternate embodiments involve sampling more heavily in other areas, or in more than one selected area.

Block 72 of Fig. 3 includes the creation of a histogram and multiple region bar graph from the sampled image data, and evaluation of the degree of exposure as high clip, over exposed, properly exposed, under exposed or low clip. For ease of wording, the terms over exposed and under exposed will generally be used to refer to moderate over or moderate under exposure, and not to include the more severe form of under or over exposure that places pixels at one or the other extreme of the intensity scale. These more severe forms are indicated by the terms low clip and high clip as referred to above, or low clipping and high clipping, or descriptively as extreme under or extreme over exposure.

For ease of illustration of the histogram and bar graph process, suppose the grid of 25 pixels in Fig. 5 is the sampled image intensity data. Also, for simplicity, the light intensity values are assumed to have the range of 1 to 1000. Each square 114 represents one pixel of the sampled image, and has a number assigned which is the value of light intensity of the pixel selected for illustrative purposes. In addition to sampling the image data, the processor 12 further simplifies and speeds

calculations by selecting a predetermined number of regions of intensity to create a bar graph to aid in the evaluation instead of evaluating each pixel. For this illustration, suppose the number of regions of light intensity selected is five, the first region being the number of pixels with light intensities of 1-2, the second having values of 3 and 4, the third, 5 and 6, the fourth 7 and 8 and the fifth, 9 and 10.

Fig. 6A shows a histogram, i.e., a plot of pixel quantity versus light intensity with the original quantity of each light intensity recorded as small circles. The histogram of "quantities" of pixels with a given intensity versus "intensity" is overlaid by the five region bar graph. Region 1 is represented by bar 116, region 2 by bar 118, region 3 by bar 120, region 4 by bar 122 and region 5 by bar 124. Bar 124 is of zero height because there are no pixels in the corresponding intensity range, which is from intensities greater than 800, up to and including 1000. The height of bar 116 is the number of pixels having intensities from zero to 200, including one pixel at intensity 100 and five at intensity 200, for a total of 6 pixels defining the height of the bar. The other bars are similarly derived. The modified bars 126-134 are outlined by dashed lines and are the result of the quantity of pixels having scaled intensity values, the quantities noted by the small x's. The purpose of the scaling is related to scaling in blocks 78, 80 and 88 for the purpose of arriving at a scaling factor, which is used to multiply a previous flash to yield a correct final flash energy. This process will be fully described in the following discussions of the figures of the drawing. For example, the first region after intensity scaling has a quantity of pixels equal to one. The pixel initially had an intensity of 100, which is noted by the "0" identified by item no. 138. After an analysis which will be fully explained, the intensity is multiplied by a scaling factor which moves the position of the quantity notation to the intensity 106.25 indicated by the "x" and identified by item no. 136, thus shifting its position

to the right on the intensity scale. The second "0" indicated by item no. 140 indicates a quantity of five pixels with intensity of 200. The scaling shifts this value above the 200 limit of region 1 and into region 2 as noted by the second x identified by item no. 142. Therefore, the new region 1 has only one pixel as indicated by the dashed bar 126. A similar explanation follows for the other regions. Of particular note is region 5 which begins with no pixels, but due to the scaled values moving higher in intensity, the dashed/modified region 5 has one pixel. Note also that because a multiplicative scaling factor was used, the horizontal distance (intensity difference) between the first "0" and the first "x" is much smaller than the intensity difference between the last "0" 144 and last "x" 146. For ease of reference, the quantities of pixels and their intensities before and after scaling are shown in the table of Fig. 6B. The above example will be referred to in the following detailed description of the exposure analysis performed by blocks 72 and the scaling operations performed in blocks 78, 80 and 88.

The "analyze exposure" block 72 of Fig. 3 represents the creation and analysis of the bar graph of the actual sampled image intensity data. This analysis can now be more fully understood through reference to Fig. 7. Block 152 indicates the input of the sampled image from block 71 of Fig. 3, and blocks 154 and 156 refer to the making of the histogram and bar graph as explained above in reference to Figs. 5 and 6. According to block 158, region 1 of the bar graph is evaluated and if it contains more than a preset high value, the exposure condition is termed low clipping (block 160). Similarly, in block 162, region 5 is evaluated and if it contains more than a preset value of pixels the exposure is termed high clipping (block 164). If neither high or low clipping occur, region 3 is evaluated (block 166) and if the number of pixels is found to be within preset upper and lower limits, the exposure is termed to be "ok" (block 168). Otherwise, if region 3 has a high number

of pixels exceeding the upper limits, region 2 is evaluated (block 170). If it has a low number of pixels, the exposure is "ok" (block 172); and if not, the condition is overexposed (block 174). If the region 3 (block 166) analysis shows the number of pixels below the low limit, region 4 is evaluated for a high number of pixels (block 176). If it has a high number above a preset level, the exposure is "ok" (block 178). Otherwise, the condition is underexposed (block 180).

If the analysis indicates that nearly all the pixels have intensities in region 1, the exposure is termed "low clipping" or "low clip". If nearly all of the pixels have intensity in region 5, this would be high clipping (high clip). If neither low or high clipping exists, the analysis proceeds to blocks 78 or 80 in Fig. 3. Referring again to the simplified example of Figs. 5 and 6, and to Fig. 8, the scaling operations performed in blocks 78 and 80 can be more fully understood. The solid line bar graph of Fig. 6A is evaluated according to block 72 explained above, and the condition would be noted as under exposed. A vertical line 148 (Fig. 6A) is marked showing the location of a value S equal to 850. S represents a point on a curve of "input light intensity" versus "output" of the image optical pickup 30 (curve not shown) where the curve becomes nonlinear, i.e. where the pickup begins to saturate, a condition indicative of excessive light input. A value "C" is also noted in Fig. 6A, marked with a line 150 as the value 800. The value "C" is supposed to be the point on the distribution of pixel intensities above which lie .5% of the pixels. This point is not clear in Fig. 6A because there are only 25 total pixels and .5% is less than one. For illustrative purposes, it is placed on the value 800 which includes the pixel of greatest intensity. According to a preferred embodiment of the present invention, a scaling factor S/C is defined, where S is as defined above, and C is the above defined value for a given distribution of unscaled pixels. The factor S/C is estimated by the processor 12 and used in the cases of blocks 78 and 80 to either multiply

the first flash energy to obtain an estimated final flash energy for acceptable exposure, or to adjust the camera parameters if ambient light is the source. For example, in Fig. 6A, the ratio of S/C = 850/800 = 1.0625. For reference, Fig. 6B is a table giving the quantities and intensities before and after scaling for Fig. 6A. Multiplying a first flash energy by the factor S/C and activating the flash would result in a pixel intensity distribution as shown by the "x"'s in Fig. 6A, with a bar graph as indicated by the dashed lines. Note that the dashed lines are displaced horizontally from the solid lines so they can be seen, but in fact they are horizontally representative of the same intensity. Also note that the scaled plot has a pixel at the value S equal to 850. A more realistic distribution of pixels might be more instructive at this point, and such a distribution is shown in Fig. 8. The solid curve "H" represents an original distribution resulting from a first flash. The point "C" at intensity 700 is supposed to represent the intensity point above which .5% of the pixels lie. The dashed curve "H" represents the plot of the scaled intensities which should result if the pixels represented by the solid curve H are multiplied by the factor S/C. In the case of Fig. 8, the value of S/C is S/C = 850/700. Note the area above S = 850 in the dashed curve. It should represent .5% of the total number of pixels. A reverse process with an S/C less than unity would result if the point C were initially above the point S, i.e. S/C < 1.

The scaling processes of blocks 78 and 80 are illustrated in block form in Fig. 9. Block 182 indicates the need for the histogram of the sampled image from block 72. Block 184 describes the need of the value S. Block 186 includes the operation of finding the point C on the histogram, above which .5% of the pixels lie. Block 188 gives the ratio of S/C as the scaling factor.

Referring now to Figs. 10 and 11, the operations performed according to the "activate light source" blocks 92 and 84 can be

more fully understood in the case when the flash is used. Block 190 defines the inputs required. These are the desired flash energy "E_{flash}", the voltage on the flash capacitor "Vi", and the value of the flash capacitor "C". The capacitance "C" of the flash capacitor is a constant, and is a predetermined, pre-programmed value. The desired flash energy "E_{flash}" is determined as described in relation to blocks 78 or 80, depending on whether the result of the first flash was a condition of over or under exposure, and is $E_{flash} = S/C\ (E_1)$ where E_1 is the previous flash. E_1 is the energy of the first flash for the activate blocks 92 and 84. The determination of S/C was explained above for blocks 78 and 80. When a correct exposure condition is the result of the first flash, the value of S/C is unity.

In the case where high or low clipping results from first flash or a first sampled ambient light, the scaling procedure of blocks 92 and 84 is not used. In these cases the scaling factor is a predetermined setting for flash operation, either 1/2 for high clipping or 2 for low clipping as indicated in blocks 74 and 76, although other values are included in the spirit of the invention. The activate flash blocks 92 and 84 also define the operation of sensing the voltage Vi prior to a flash.

With the above discussed values of E_{flash}, Vi and C, the processor 12 performs the calculation indicated in block 192 of Fig. 10 for Vc. Vc is the value of the flash capacitor voltage at which point the desired flash energy is expended in the flash unit. Solving the equation yields

$$Vc = \frac{2}{C}\sqrt{\frac{1}{2}CVi^2 - E_{flash}}$$

The flash operation described above is more fully explained in reference to Fig. 11. The figure shows a capacitor 194, switch 196 and flash bulb 198 arrangement. The voltage V across the capacitor terminals 200 and 202 is monitored. The value of Vi prior to a flash, as described above is measured and used in the calculation of a lesser value of voltage Vc at which point the capacitor 194 will have discharged the desired amount of

energy to the flash bulb 198. The transfer of energy from the capacitor 194 to bulb 198 begins when a signal on line 204 causes switch 196 to connect line 200 to line 206 to the bulb 198. When the voltage between lines 200 and 202 (across capacitor 194) is sensed to be equal to Vc, a second signal is applied on line 204 causing switch 196 to disconnect line 200 from line 206.

Referring to Fig. 12, there is shown a block diagram detailing the operations indicated by the second exposure analysis block 88 of Fig. 3. As discussed in reference to Fig. 3, if the exposure resulting from the first flash or first ambient light sample is either high or low clipping, a second flash or second ambient light sampling is performed of either lower or higher energy respectively for the flash, or adjusted parameters for the ambient light. This flash or sampling, described above in reference to block 84, provides an adjusted light to grab an image (block 86) which is analyzed according to block 88.

According to Fig. 12, the grabbed image (block 86, Fig. 3) is passed as indicated by arrow 208, and is sampled (block 210) and then examined according to the "analyze exposure" block 212. Blocks 210 and 212 define the same operations on the image data of the second flash or second sample as blocks 71 and 72 perform on the image data from the first flash or first sample. Similarly, if the result of the analysis is a determination that the exposure is correct, the sequence of activities defined by blocks 214-220 is identical to that of blocks 92-96 of Fig. 3. This is in response to a correct exposure resulting from the first flash or first ambient light sample. The additional block 220 indicates the option of supplying a notice to the operator that the exposure is okay. This notice can be in any of a variety of forms known to those skilled in the art, such as a light bulb of any color, or LED read out, etc. In the event the second flash results in low clipping (224), the processor 12 sets the flash to a maximum intensity as indicated by block 226.

The flash or sample is then activated (block 228), the image is grabbed 230 and recorded 232. Similarly, if the second flash or second sample yields a high clip condition 234, the processor 12 directs the flash to a minimum (236). In the case where the light source was ambient light, the parameters are set for minimum light. The flash or sampling is then activated (228), the image grabbed (block 230) and recorded (232).

If the result of the second flash or second ambient sample is a condition of under exposure (238) meaning a condition not severe enough to be low clipping, and if the result of the first flash (240) or first sampling is under exposure 242, the second flash or sampling is scaled with a scaling factor S/C as indicated by block 244. The process of determining the scale factor S/C is the same as that described above in reference to block 80 of Fig. 3. The flash or sampling is then activated (228). In the case of a flash, the energy is set to a level equal to $E_2(S/C)$ where E_2 is the second flash energy and S/C is the scaling factor. In the case of ambient light, the parameters of the last sampling are scaled to adjusted parameters using the factor S/C and an optional look-up table. The image is then grabbed 230 and recorded 232. Similarly, if the first result is "over exposure" (246), the preferred embodiment simply scales the second flash energy level or the camera parameters for ambient light (block 248) by determining the scale factor S/C. The determination of the scale factor S/C is again done in the same way as that described in relation to block 80 of Fig. 3.

In the case where the analysis of the sampled image of the second flash results in a condition of over exposure (250), and the result of the first flash (252) is under exposure (254), the second flash energy is scaled by the value S/C (block 248) to obtain the final flash energy. Also, if the first flash is over exposed (256), the second flash energy is again scaled (block 258) by the value S/C for final flash energy. Similarly for an ambient light source, the camera parameters are scaled from the

parameters used in the second light sampling. The scaling operations in blocks 244, 248 and 258 are all similar to the scaling operations of blocks 78 and 80 as described in reference to Fig. 3. The only difference is that the scaling blocks of Fig. 12 scale the second flash energy or second camera parameters rather than the first. Also, it should be pointed out that scaling the second flash energy/parameter is done for simplicity in the cases where the second exposure image is under exposed and the first image is over exposed (ref. 238 and 246), and the case when the second image is over exposed and the first is under exposed (refs. 250 and 254). Alternate embodiments of the invention include exposure methods of scaling in block 248 when the first and second exposure bracket the correct exposure. For example, in the case where the first exposure results in under exposure and the second results in over exposure, a weighted average could be used. For the flash case, an example could be to assume a final flash energy $Ew = A(E_2 - E_1) - E_1$ where A is a preset fraction between zero and one, the selected value depending on the estimated accuracy of the second flash. For example, it would normally be assumed that the second flash energy is closer to correct than the first and a choice of A = .7 might be selected. Other weighted averages are also included in the spirit of the present invention.

The "Notice" blocks 260-268 define an optional visual or recorded message to the operator of the particular exposure condition existing when a picture is taken.

Although a preferred embodiment of the present invention has been described above, it will be appreciated that certain alterations or modifications thereon will be apparent to those skilled in the art. It is therefore that the appended claims be interpreted as covering all such alterations and modifications that fall within the true spirit and scope of the invention.

What is claimed is:

CLAIMS

1. A flash method for a digital camera, said method comprising:

a) activating a flash with a flash energy;

b) grabbing an image to create image intensity data;

c) analyzing corresponding image intensity data of an image derived from said flash to determine a flash degree of exposure;

d) calculating a subsequent flash energy level to achieve a corrected degree of exposure;

e) repeating steps (a) through (d) until an acceptable final flash energy level for achieving a correct exposure is determined; and

f) activating a flash at the determined acceptable final flash energy.

2. A method as in claim 1 further comprising a step prior to step (a) consisting of determining by analysis of ambient light or user election whether a flash is needed.

3. A method as recited in claim 1 wherein said calculating includes multiplying the energy level of said flash by a pre-set constant factor if said flash degree of exposure is severely under exposed or severely over exposed.

4. A method as recited in claim 1 wherein said calculating further includes

a) setting said subsequent flash energy level at the maximum flash energy level for a final flash energy level if two or more consecutive flash degrees of exposure are severely under exposed; and

b) setting said subsequent flash energy level at a minimum flash energy level for a final flash energy level if two or more consecutive flash degrees of exposure are severely over exposed.

5. A method as recited in claim 1 wherein said activating a flash with a flash energy includes

a) detecting an initial voltage of a flash capacitor;

b) calculating a cutoff voltage of said flash capacitor at which voltage a quantity of energy equal to said flash energy is transferred to power said flash; and

c) transferring a quantity of energy equal to send flash energy to said flash.

6. A method as recited in claim 1 wherein said analyzing includes

a) sampling a first quantity of data from a first area of said image; and

b) sampling a second quantity of data from a second area of said image.

7. A method as recited in claim 1 wherein said analyzing further includes

a) creating a histogram of quantity of said image intensity data versus intensity;

b) preparing a bar graph with a multiplicity of regions from said histogram; and

c) evaluating the quantity of data in each said region of said bar graph.

8. A method as recited in claim 7 wherein said calculating includes scaling said image intensity data to determine a scaling factor to multiply times said flash energy to calculate a final acceptable flash energy if said degree of exposure is under exposed or over exposed.

9. A method as recited in claim 8 wherein said scaling said image intensity data includes

a) evaluating said histogram to determine a first intensity level above which a predetermined percentage of said intensity data lie; and

b) dividing a predetermined intensity level selected as a level at which said grabbing to create image intensity data becomes non-linear, by said first intensity level to create said scaling factor.

10. A method as recited in claim 1, wherein said calculating includes calculating a weighted average of a first energy level of a flash which resulted in under exposure, and a second energy

level which resulted in over exposure to obtain an estimated final flash energy level.

11. A method as recited in claim 2, wherein said determining by analysis includes

a) sampling a quantity of ambient light with said camera having a first set of camera parameters;

b) grabbing an image to create image intensity data;

c) analyzing corresponding image intensity data of an image derived from said ambient light to determine an ambient degree of exposure;

d) calculating subsequent camera parameters to sample a quantity of ambient light to achieve a corrected degree of exposure; and

e) repeating steps (a) through (d) until a said set of camera parameters are determined resulting in an acceptable quantity of ambient light for achieving a correct exposure, or until it is determined that a flash is needed.

12. A method as recited in claim 11 further comprising:

sampling a quantity of ambient light equal to said acceptable quantity of ambient light.

13. A method as recited in claim 3 wherein said calculating further includes

a) setting said subsequent flash energy level at the maximum flash energy level for a final flash energy level if two or more consecutive flash degrees of exposure are severely under exposed; and

b) setting said subsequent flash energy level at a minimum flash energy level for a final flash energy level if two or more consecutive flash degrees of exposure are severely over exposed.

14. A flash method for a digital camera, said method comprising:

a) activating a flash with a first flash energy;

b) grabbing a first image to create first image intensity data;

c) analyzing corresponding first image intensity data of said first image derived from said first flash to determine a first degree of exposure;

d) scaling said first flash energy if said first degree of exposure is under or over exposed to determine a final flash energy level; and

e) activating said flash at said final flash energy level.

15. A flash method as recited in claim 14 further comprising:

a) multiplying said first energy level by a pre-determined factor if said first degree of exposure is severely under exposed or severely over exposed to determine a second flash energy level;

b) activating said flash with said second flash energy level;

c) grabbing a second image to create second image intensity data;

d) analyzing corresponding second image intensity data of said second image derived from said second flash to determine a second degree of exposure;

e) scaling said second flash energy level if said second degree of exposure is under exposed or over exposed to determine a final flash energy; and

f) activating said flash with said final flash energy.

16. A flash method as recited in claim 15, further comprising:

a) setting a final flash energy equal to a maximum flash energy if said second degree of exposure is severely under exposed;

b) setting a final flash energy equal to a minimum flash energy if said second degree of exposure is severely over exposed; and

c) activating said flash with said final flash energy.

17. A flash apparatus for a digital camera, said apparatus comprising:

a) means for activating a flash with a flash energy;

b) means for grabbing an image to create image intensity data;

c) means for analyzing corresponding image intensity data of an image derived from said flash to determine a flash degree of exposure;

d) means for calculating a subsequent flash energy level to achieve a corrected degree of exposure;

e) means for repeating steps (a) through (d) until an acceptable final flash energy level for achieving a correct exposure is determined; and

f) means for activating a flash at the determined acceptable final flash energy.

18. An apparatus as in claim 17 further comprising means for determining by analysis of ambient light or user election whether a flash is needed.

19. An apparatus as recited in claim 17 wherein said means for calculating includes means for scaling said image intensity data to determine a scaling factor to multiply times said flash energy to calculate a final acceptable flash energy if said degree of exposure is under exposed or over exposed.

20. An apparatus as recited in claim 17 wherein said means for activating a flash with a flash energy includes

a) means for detecting an initial voltage of a flash capacitor;

b) means for calculating a cutoff voltage of said flash capacitor at which voltage a quantity of energy equal to said flash energy is transferred to power said flash; and

c) means for transferring a quantity of energy equal to send flash energy to said flash.

21. An apparatus as recited in claim 17 wherein said means for analyzing includes

a) means for sampling a first quantity of data from a first area of said image; and

b) means for sampling a second quantity of data from a second area of said image.

22. An apparatus as recited in claim 17 wherein said means for analyzing further includes

a) means for creating a histogram of quantity of said image intensity data versus intensity;

b) means for preparing a bar graph with a multiplicity of regions from said histogram; and

c) means for evaluating the quantity of data in each said region of said bar graph.

23. An apparatus as recited in claim 19 wherein said means for scaling said image intensity data includes

a) means for evaluating said histogram to determine a first intensity level above which a predetermined percentage of said intensity data lie; and

b) means for dividing a predetermined intensity level selected as a level at which said grabbing to create image intensity data becomes non-linear, by said first intensity level to create said scaling factor.

24. An apparatus method as recited in claim 17, wherein said means for calculating includes means for calculating a weighted average of a first energy level of a flash which resulted in under exposure, and a second energy level to obtain an estimated final flash energy level.

25. A flash apparatus for a digital camera, said apparatus comprising:

a) means for activating a flash with a first flash energy;

b) means for grabbing a first image to create first image intensity data;

c) means for analyzing corresponding first image intensity data of said first image derived from said first flash to determine a first degree of exposure;

d) means for scaling said first flash energy if said first degree of exposure is under or over exposed to determine a final flash energy; and

e) means for activating said flash at said final flash energy level.

26. A flash apparatus as recited in claim 25 further comprising:

a) means for multiplying said first energy level by a pre-determined factor if said first degree of exposure is severely under exposed or severely over exposed to determine a second flash energy level;

b) means for activating said flash with said second flash energy level;

c) means for grabbing a second image to create second image intensity data;

d) means for analyzing corresponding second image intensity data of said second image derived from said second flash to determine a second degree of exposure;

e) means for scaling said second flash energy level if said second degree of exposure is under exposed or over exposed to determine a final flash energy; and

f) means for activating said flash with said final flash energy.

27. A flash apparatus as recited in claim 26, further comprising:

a) means for setting a final flash energy equal to a maximum flash energy if said second degree of exposure is severely under exposed;

b) means for setting a final flash energy equal to a minimum flash energy if said second degree of exposure is severely over exposed; and

c) means for activating said flash with said final flash energy.

ABSTRACT OF THE DISCLOSURE

An intelligent flash system for a digital camera having components including an image optical pickup, an interface circuit, a flash unit and a processor. Upon activation of the camera, ambient lighting conditions are evaluated and if flash energy is required, a first low energy pre-flash is radiated, the reflected light received by the optical pickup having a multiplicity of pixels, and the output of the pixels converted to image intensity data by the interface circuit. The processor samples the image intensity data, weighing the center image area more heavily, and creates a histogram plot of quantity of pixels v.s. intensity, and separates the plot into a bar graph from which a determination of exposure is obtained. The histogram is then used to calculate a multiplicative scaling factor used to multiply the first flash energy to an estimate of a flash energy for correct exposure. Conditions of extreme over and under exposure result in the activation of a second flash at an adjusted energy level. The image data of the second flash is then analyzed and the exposure compared with the result of the first flash. A final determination of flash energy is then made based upon the results.

DHJ:RLF:0208z

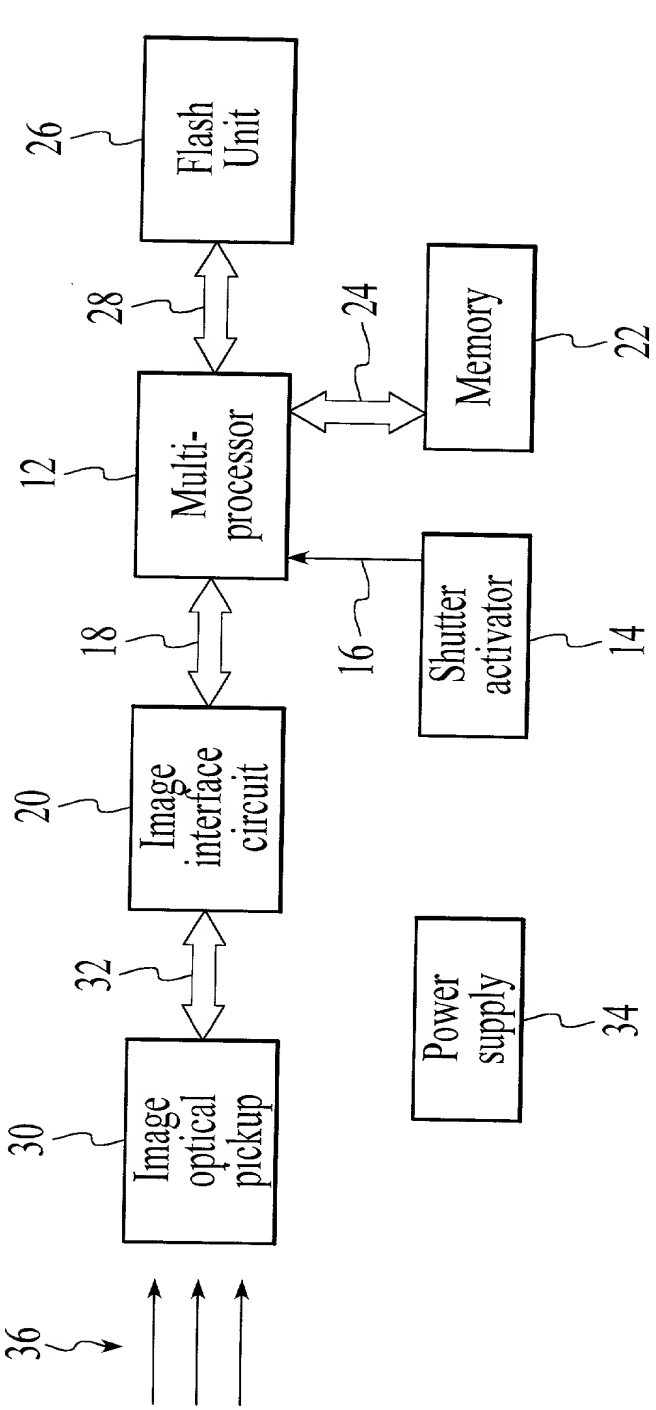

10
26
Flash Unit
28
24
Memory
22
12
Multi-processor
18
16
Shutter activator
14
20
Image interface circuit
32
Power supply
34
30
Image optical pickup
36

FIG. 1

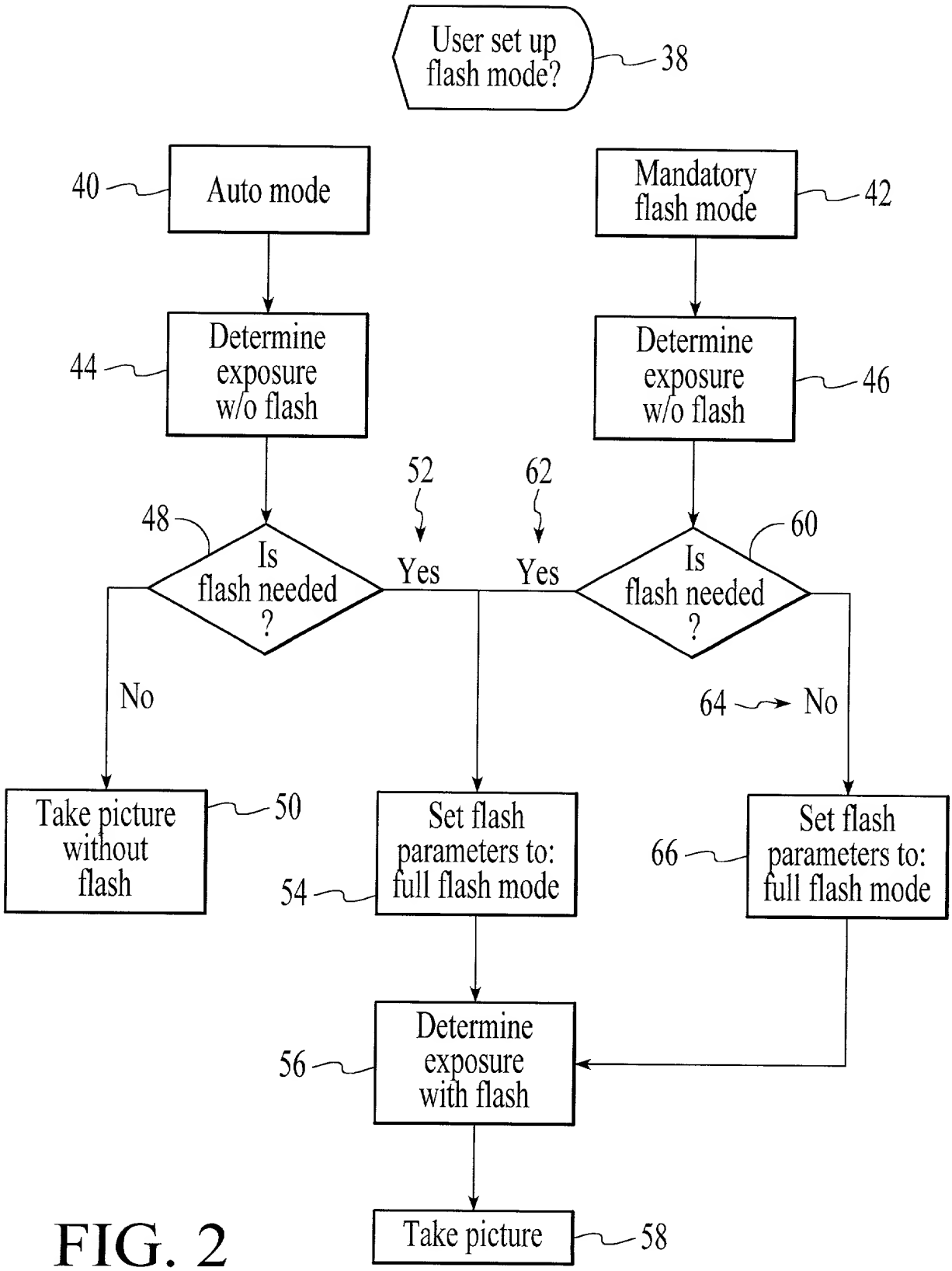

User set up flash mode?
38
40
Auto mode
Mandatory flash mode
42
Determine exposure w/o flash
44
Determine exposure w/o flash
46
52
62
48
Is flash needed ?
Yes
Yes
Is flash needed ?
60
No
64
No
Take picture without flash
50
Set flash parameters to: full flash mode
54
Set flash parameters to: full flash mode
66
Determine exposure with flash
56
Take picture
58

FIG. 2

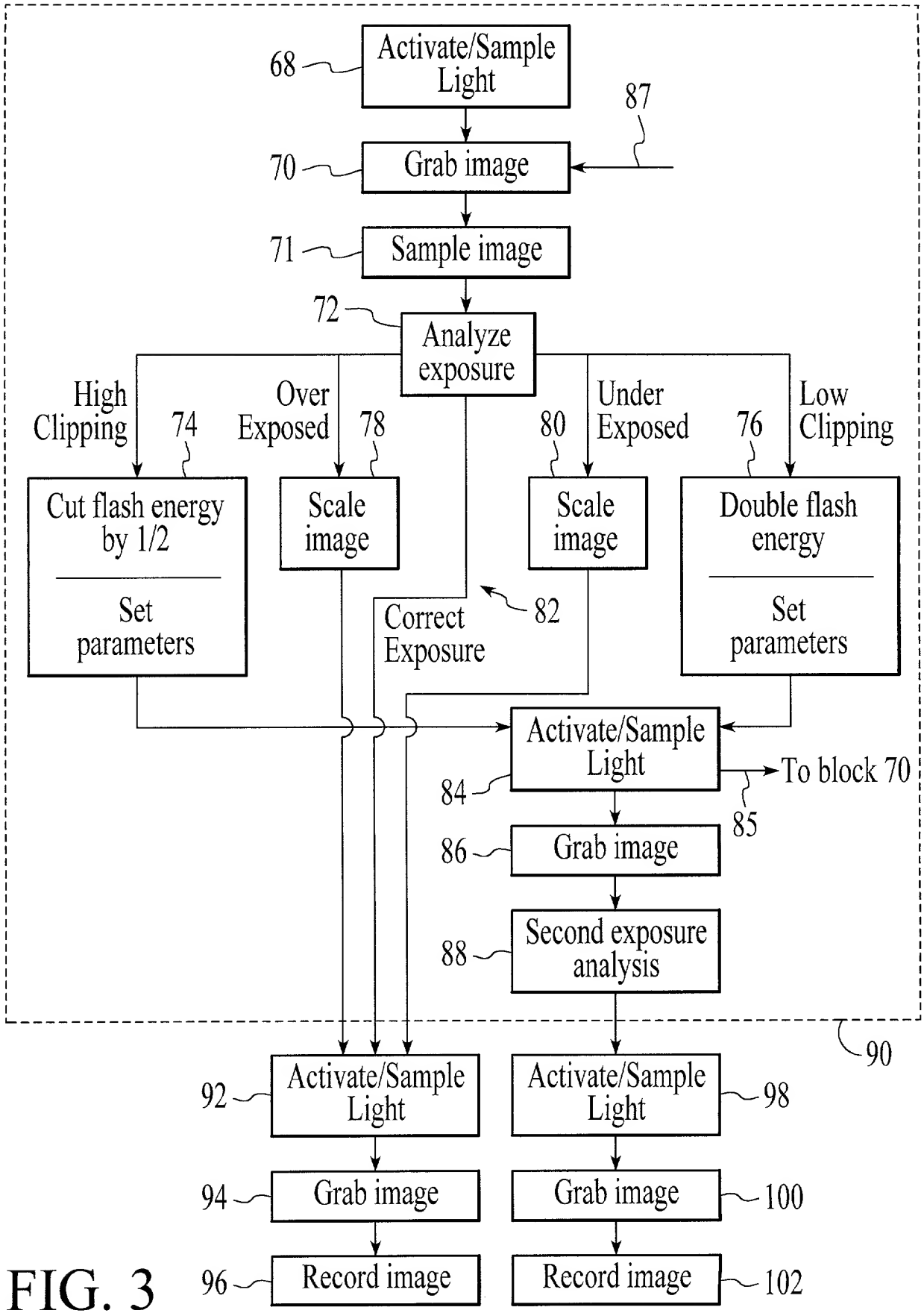

68
Activate/Sample Light
87
70
Grab image
71
Sample image
72
Analyze exposure
High Clipping
74
Over Exposed
78
80
Under Exposed
76
Low Clipping
Cut flash energy by 1/2
Set parameters
Scale image
Scale image
Double flash energy
Set parameters
Correct Exposure
82
Activate/Sample Light
To block 70
84
85
86
Grab image
88
Second exposure analysis
90
92
Activate/Sample Light
Activate/Sample Light
98
94
Grab image
Grab image
100
96
Record image
Record image
102

FIG. 3

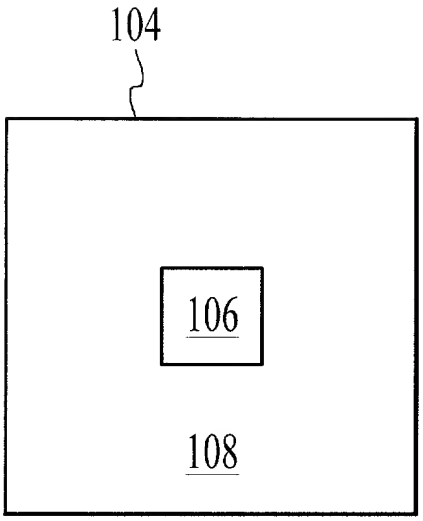


FIG. 4A

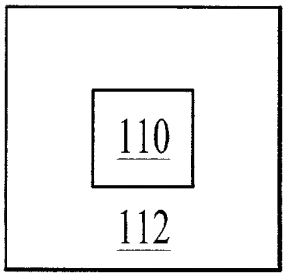
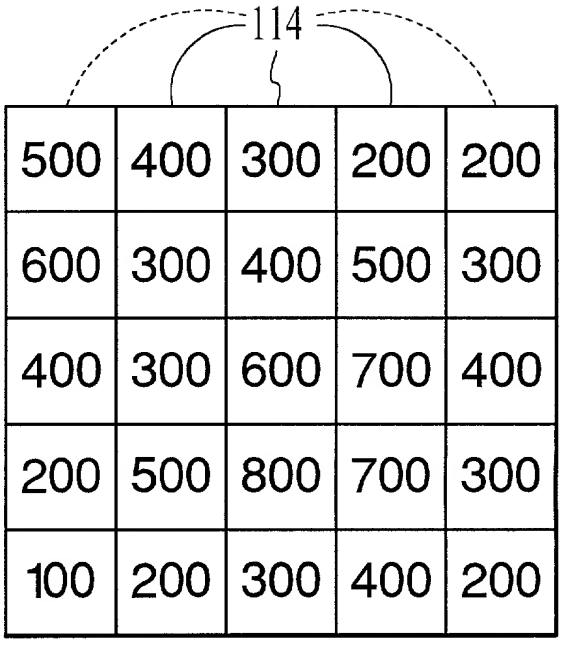


FIG. 4B



500	400	300	200	200
600	300	400	500	300
400	300	600	700	400
200	500	800	700	300
100	200	300	400	200

FIG. 5

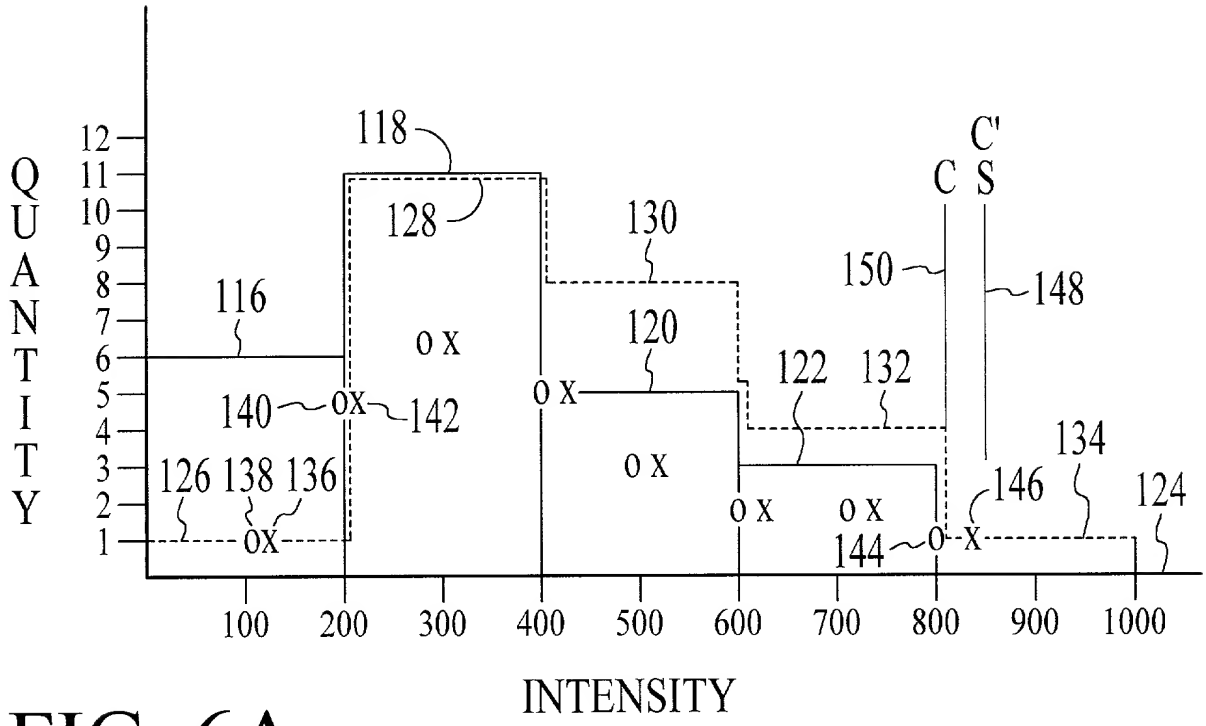


FIG. 6A

FIG. 6B

QTY	Original Intensity	Scaled Intensity
1	100	106.25
5	200	212.50
6	300	318.75
5	400	425.00
3	500	531.25
2	600	637.50
2	700	743.75
1	800	850.00
0	900	
0	1000	

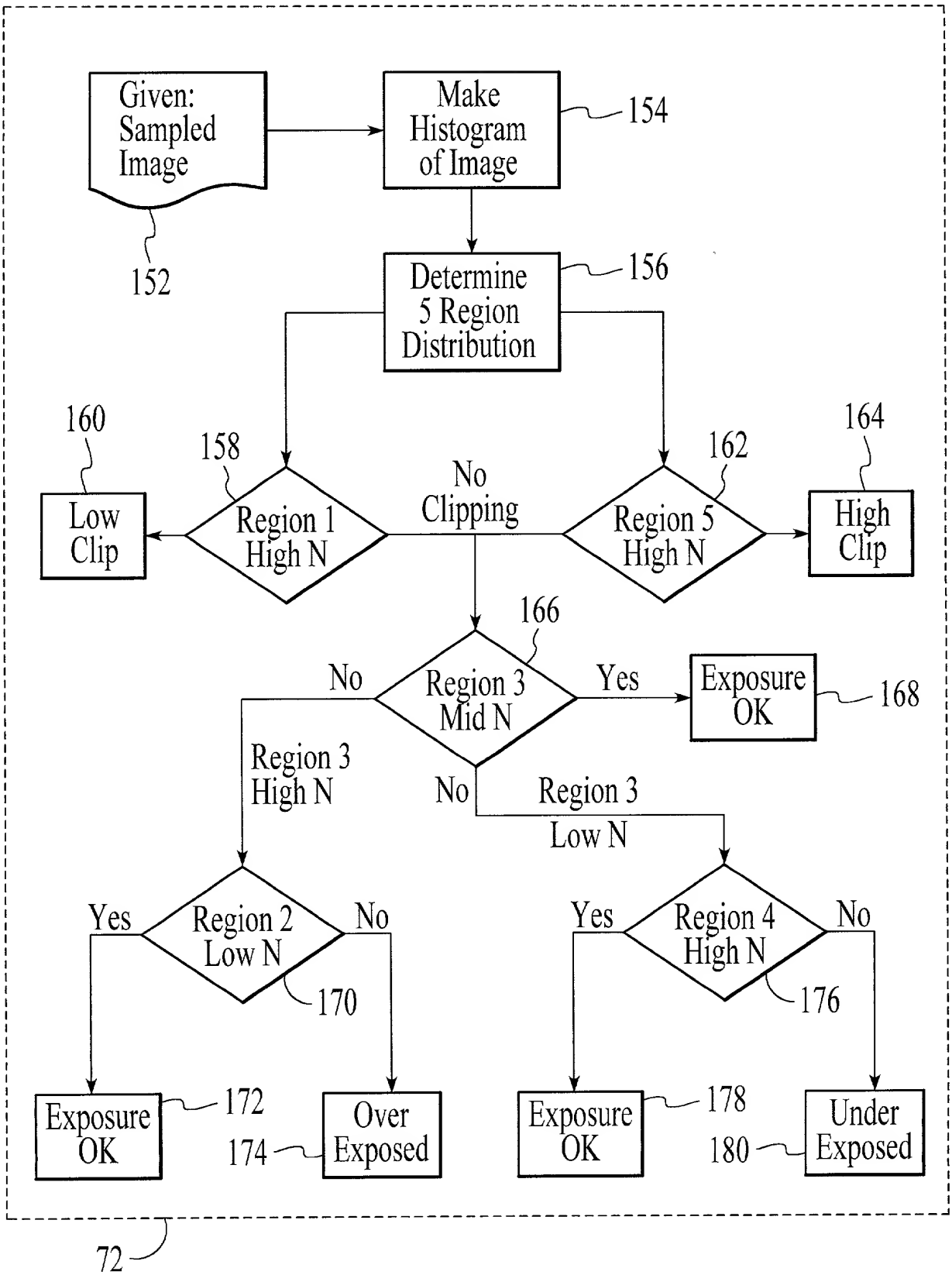

Given: Sampled Image
152
Make Histogram of Image
154
Determine 5 Region Distribution
156
158
160
162
164
Region 1 High N
Low Clip
No Clipping
Region 5 High N
High Clip
166
Region 3 Mid N
No
Yes
Exposure OK
168
Region 3 High N
No
Region 3 Low N
Region 2 Low N
Yes
No
170
Region 4 High N
Yes
No
176
Exposure OK
172
Over Exposed
174
Exposure OK
178
Under Exposed
180
72

FIG. 7

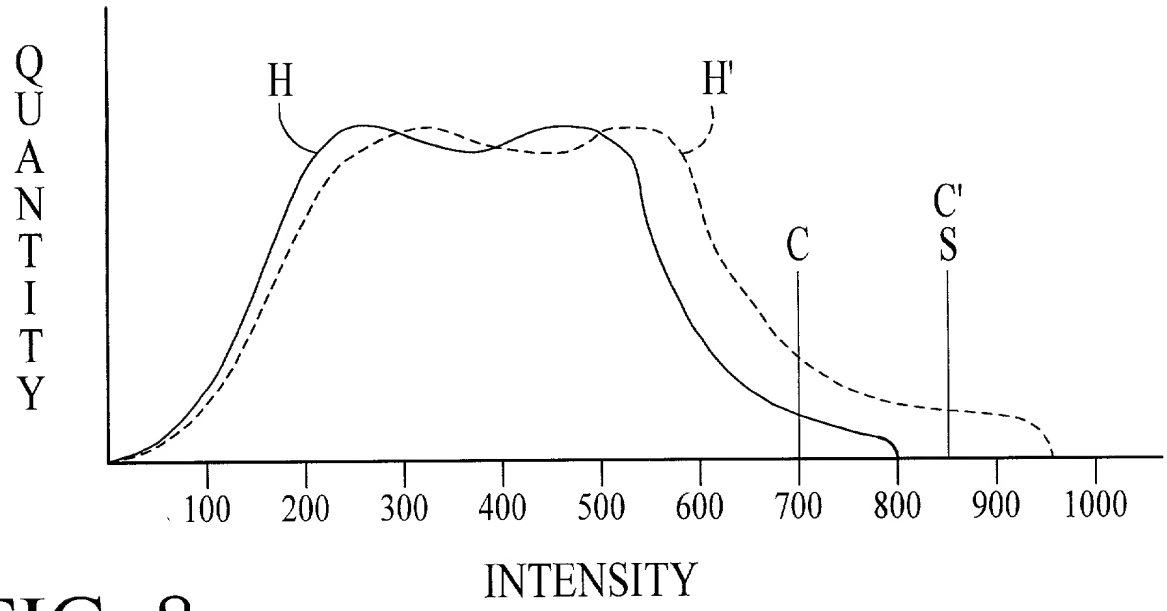

QUANTITY
H
H'
C
C'
S
100
200
300
400
500
600
700
800
900
1000
INTENSITY

FIG. 8

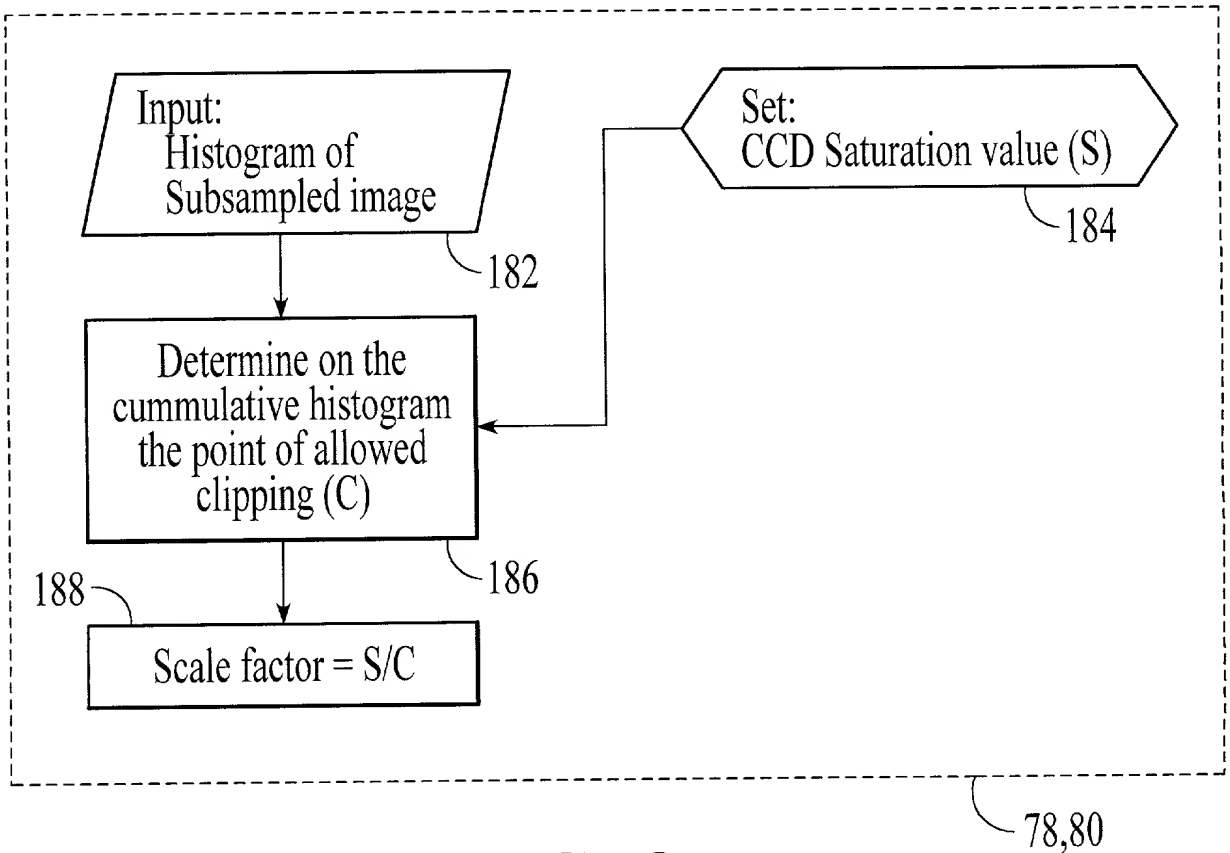

Input:
Histogram of
Subsampled image
182
Set:
CCD Saturation value (S)
184
Determine on the
cummulative histogram
the point of allowed
clipping (C)
186
188
Scale factor = S/C
78,80

FIG. 9

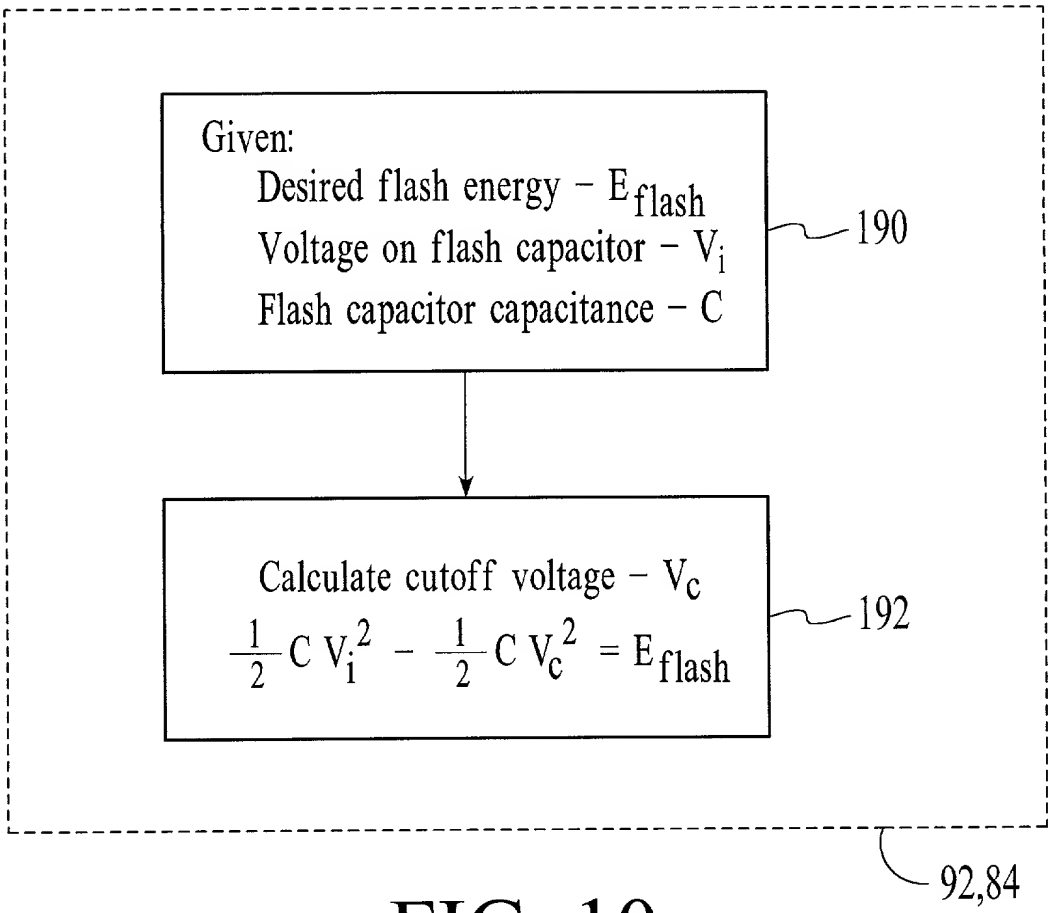

Given:
Desired flash energy – E_{flash}
Voltage on flash capacitor – V_i
Flash capacitor capacitance – C
190
Calculate cutoff voltage – V_c
$\frac{1}{2} C V_i^2 - \frac{1}{2} C V_c^2 = E_{flash}$
192
92,84

FIG. 10

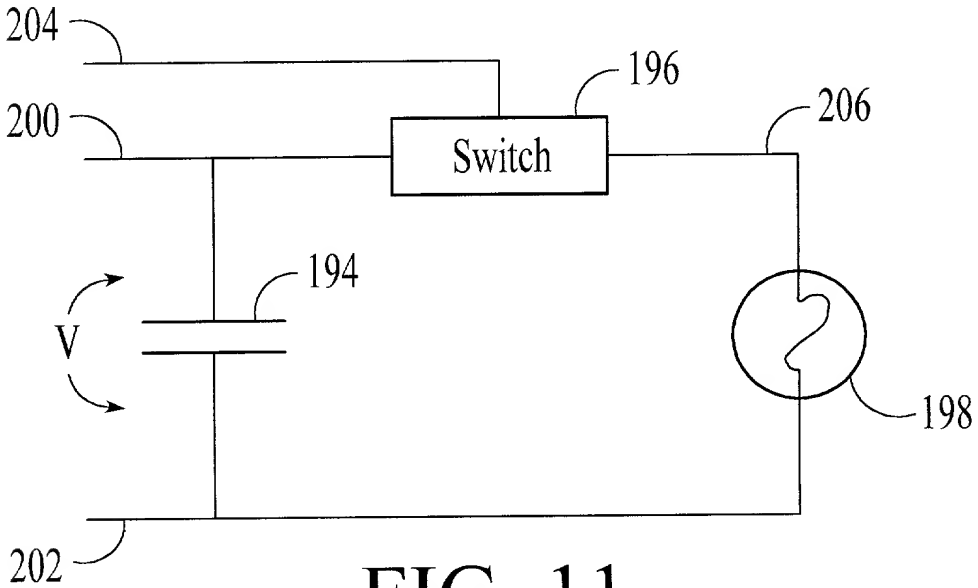
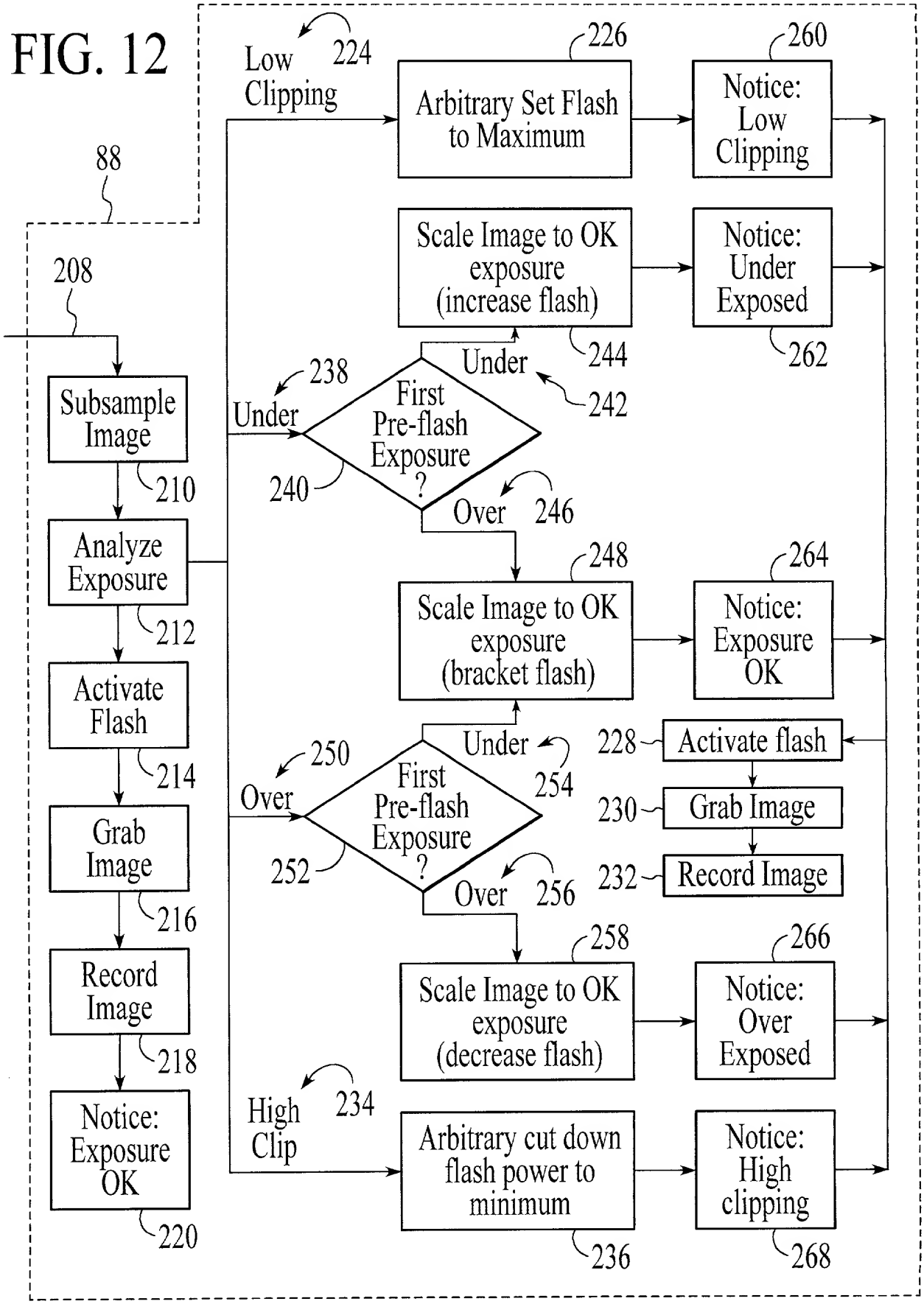

204
200
196
206
Switch
194
V
198
202

FIG. 11

FIG. 12


88
208
Subsample Image
210
Analyze Exposure
212
Activate Flash
214
Grab Image
216
Record Image
218
Notice: Exposure OK
220
Low Clipping
224
Arbitrary Set Flash to Maximum
226
Notice: Low Clipping
260
Scale Image to OK exposure (increase flash)
244
Notice: Under Exposed
262
Under
242
238
Under
First Pre-flash Exposure ?
240
Over
246
Scale Image to OK exposure (bracket flash)
248
Notice: Exposure OK
264
Under
254
250
Over
First Pre-flash Exposure ?
252
Over
256
228
Activate flash
230
Grab Image
232
Record Image
Scale Image to OK exposure (decrease flash)
258
Notice: Over Exposed
266
High Clip
234
Arbitrary cut down flash power to minimum
236
Notice: High clipping
268

COMBINED DECLARATION, POWER OF ATTORNEY & PETITION

DECLARATION

As a below-named inventor, I hereby declare that:

(i) my residence, post office address and citizenship are as stated below next to my name;

(ii) I have reviewed and understand the contents of the attached specification including the drawing and claims as amended by any amendment referred to below;

(iii) I believe I am the original, first and sole inventor (if only one is listed below) or a joint inventor (if plural inventors are named below) of the invention entitled:

INTELLIGENT CAMERA FLASH SYSTEM

as described and claimed in the specification which

☒ is attached hereto.

☐ was filed on _____ as U.S. Patent Application Serial No. _____.

☐ was described and claimed in PCT International Application No. _____ filed on _____ and as amended under PCT Article 19 on _____.

(iv) I acknowledge my duty to disclose information of which I am aware which is material to the examination of this application, in accordance with 37 CFR 1.56(a);

(v) I do not know and do not believe that the same was (1) ever known or used in the United States before my or our invention thereof, or (2) patented or described in any printed publication in any country before my or our invention thereof for more than one year prior to this application, or (3) in public use or on sale in the United States more than one year prior to this application;

I declare further that all statements made above of my own knowledge are true and all statements made on information and belief are believed to be true; and these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

POWER OF ATTORNEY

I hereby appoint the following patent attorneys and/or patent agent(s) with full power of appointment, substitution and revocation to prosecute this application, to make alterations and amendments thereto, to receive the patent, and to transact all business in the Patent Office connected therewith.

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JILL A. HUDSON, Reg. No. 37,716

Address all telephone calls to David Jaffer at telephone number (408) 977-0120, and address all correspondence to:

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ROSENBLUM, PARISH & ISAACS
160 West Santa Clara St., Fifteenth Floor
San Jose, California 95113

PETITION

Wherefore, I pray that Letters Patent be granted to me for the invention or discovery described and claimed in the above-mentioned specification and claims, and I hereby subscribe my name to the foregoing Declaration, Power of Attorney & Petition with references to the above-mentioned specification and claims.

SIGNATURES

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Inventor's Signature: Hari. V. Date: MARCH 8, 1996

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Inventor's Signature: _____ Date: March 8, 1996

DHJ:RLF:0307x